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Technical Report No. 190

TRIAL OF AN EARLY DATA CUT-OFF (T+90 minutes) IN THE GLOBAL MODEL

by

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ABSTRACT

This technical report contains the results of subjective and objective assessments of a test of advancing the data cut-off time for the global forecast model from 3h 20min (200 min) used operationally during the test period, to 1h 30min (90min). A parallel suite trial was performed from 23 August-24 September 1995. A need for forecasts to be available sooner has been identified during a review of the User requirement for NWP, particularly for aviation and the detailed guidance from the UK mesoscale model. The test was an initial feasibility study to determine the impact on forecast quality of the earliest practical data cut-off.

The parallel suite results show that the loss of accuracy resulting from a 90 minute data cut-off is unacceptable. The objective verification shows that the losses are larger than the benefits gained from several recent model changes. The composite NWP index, based on verification against analyses, is estimated to decline by over 3 points

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1. INTRODUCTION

This technical report contains the results of subjective and objective assessments of a test of advancing the data cut-off time for the global forecast model from 3h 20min (200min) used operationally during the test period, to 1h 30min (90min). A parallel suite trial was performed from 23 August-24 September 1995 .

A need for better timeliness of some forecasts has been identified during a review of the User requirement for NWP. Aviation customers would like global forecasts of wind and temperatures to be available sooner, and the detailed guidance from the UK mesoscale model needs to be produced as soon as possible after receipt of the latest data to be useful to CFO in issuing guidance to outstations and national public weather forecasts. A project to investigate the technical solutions to meet this need has been initiated. The test reported here was an initial feasibility study to determine the impact on forecast quality of the earliest practical data cut-off.

1.1 Experiment design

Forecasts were made once per day from 12UTC with the short cut-off, and compared to the operational forecasts. To gauge the worse case impact, extra forecasts were run from the 06UTC analysis; this will be referred to as the "no obs" run. It may also be used to estimate the effect of lack of timeliness of forecasts in the current operational suite, which mean that forecasts from the 00UTC main run have to be used.

2. DATA RECEIPT

The total data received during the period 1-23 September 1995 for the 12UTC analysis (with a data window of ±3 hour) are given in **TABLE 2.1** ordered by time of receipt. **Figures 2.3-2.14** show the information of **TABLE 2.1** in graphical form. By T+90min only part of the data available by T+200min has arrived except for synop reports (**Figs 2.1, 2.8**) which even for the southern hemisphere over 80% have been received. From the cumulative fraction charts (**Figs 2.1,2.2**) it is clear that **only 50-60% of the total data available by T+200min**

has been received before T+90min. (NB the full line is for NH to 30N, dash-dot SH from 30S). For sonde temperatures and winds in the northern hemisphere the fraction climbs to 80% by T+115min (the current LAM cut-off, indicated by the first vertical line), although 10% of that does not arrive until the last 10 minutes (see **Fig 2.3**) . For the southern hemisphere the fraction is 70% at T+115min and does not reach 80% until T+125min. For asynoptic data types which are more continuously observed a greater proportion of data is omitted, whatever the chosen cut-off eg AMDARs (this includes ACARs), particularly from NHemisphere (**Fig 2.4**) .AIREPs (**Fig 2.5**), SATOBs (**Fig 2.6**), DRIBUs (**Fig 2.12**) and, to a lesser extent, SATEMs (**Fig 2.7**) are similarly sensitive. Data receipt results for the same period for the 00UTC run are given in Appendix A. There are some differences in the data volumes for asynoptic types eg more AMDARs but fewer AIREPs.

Figs 2.15 and 2.16 show the positions of data omitted from the T+90 run compared to the T+200min operational run on 6 September. The missing TEMPS for Canada and North America are likely to have a large detrimental effect on forecasts for the British Isles and N Atlantic. Also the omission of such a large number of aircraft reports and AMDARs/ACARs is cause for concern in view of the purpose of an earlier cut-off, which is to provide aviation guidance sooner. Further analysis of which data was omitted from the early cut-off runs is given in section 4, where the omission is related to the deterioration of forecasts noticed subjectively.

The data cut-off at T+170min, which was recently tested in the parallel suite (Adams,1995) is also indicated on **Figs 2.1 ,2.2**. Although the impact on forecast verification scores for that trial was generally small and less than 1% worse, the biggest reductions in data were for AIREPs, AMDARs, DRIBUs and SATEMs as is also the case here.

Given the large reduction in data used a significant impact on forecast accuracy is likely. This is assessed in sections 3 and 4.

3. OBJECTIVE VERIFICATION

Many objective scores were obtained from both verification against observations and analyses. The verifying analyses used were the operational update analyses. The new FS verification software was employed which allows greater flexibility and choice of observation type. However some results were unavailable due to errors in setting up. The more important results will be given here.

3.1 Short period forecasts

The clearest impact due to the reduction in observations is found by comparing results for the operational and trial at T+12 and T+24 with those from the 06UTC T+18,T+30, the "no obs" run. These forecast periods are also the most relevant for aviation use. Results were only available from the 06UTC run for the 10 day period 5-14 September; time-mean results for this shorter period will be discussed first before the results for the full parallel trial period.

Winds

Verification against radiosondes (**Fig 3.1**) shows that an appreciable fraction of the degradation in rms vector wind errors from the "no obs" is found with the T+90min cut-off. For the no obs run the percentage changes (**TABLE 3.1** , +ve is worse) are ~5% at 850,700 hPa and around 10-14% at 200hPa ; for the T+90min rms vector wind errors around jet levels are 3 to 4% worse. Assuming these results are representative and not exaggerated due to a small sample, they should be contrasted with beneficial operational improvements, such as new gravity wave drag and orographic roughness which only improved these scores at T+24 by ~1 to 2% in a parallel suite trial (Milton et al, 1995) ; the modification to horizontal diffusion near steep orography showed a larger impact of 4 to 5% improvement in its parallel trial (Wilson et al, 1995). ***With a T+90 cut-off it is likely that half of the benefits from these improvements to the model will be lost. It can already be concluded that a 90 minute cut-off would result in an unacceptable loss of forecast accuracy.***

Verification against aireps (**Fig 3.2**) for the North Atlantic/Europe (area 2) and N Hemisphere shows a generally worse impact than that found from the sondes comparison. The absolute level of all the errors are greater than for the sondes. This probably reflects the different geographical distribution of the observations and preferential sampling of jets by aircraft. This has implications for statements of accuracy needed in the NWP user requirement and business plans; these should clearly define which observations will be used to measure the accuracies. The degradation from the T+90min trial is typically 4 to 5%, whilst the "no obs " errors are 6 to 13% worse (**TABLE 3.4**) . A similar impact is found for verification against amdars (**Fig 3.3**) particularly at upper levels where there are most observations.***These results show that, for aviation wind forecasts, typically half the improvement over the no observations run obtained with the operational cut-off is lost when a 90 minute cut-off is used.***

The conclusion from these results is that a 90min cut-off will give a significant worsening of wind forecast accuracies, and especially for aviation customers. This applies to use of the current main runs. If an earlier run has to be used due to non-availability at time needed then the 90min cut-off would be beneficial.

Temperatures

Results for the same 10 day period as for winds will be used. Over area 2 and NH the impact of the T+90 cut-off is rather greater in the lower atmosphere than for winds (**Fig 3.4**) with up to 6% worse rms errors at T+12 and up to 5% at T+24 (**TABLE 3.2**). At upper levels the degradation is ~2 to 5%, as may also be seen from the verification against aireps (**Fig 3.5** and **TABLE 3.3**). As for winds the degradation in forecast accuracy from a 90 min cut-off would seem to be too great.

3. 2 RMS ERRORS COMPARED TO OBSERVATIONS -OVERALL SUMMARY

Time-mean results for the period 5-24 September 1995 will now be discussed. Results for

forecast times T+24, T+48, T+72, T+96,T+120 and for areas "2", N. Hemisphere to 30N ("200"), Tropics 30N-30S ("300") and S. Hemisphere from 30S ("400") will be given. Unfortunately it was not possible to assess the impact of the shorter data cut-off on the T+0 fields since verification against observations for T+0 was not included with the then parallel suite set-up. Verification for T+6 was included but was incorrect; thus the earliest forecasts reliably verified were at T+12 (see section 3.1) and T+24.

TABLES 3.5-3.8 summarise the objective scores compared to radiosondes. Each shows the percentage changes in rms errors from the trial for heights, temperatures , vector winds (8 levels each) , relative humidity (3 levels) compared to the operational errors. A positive value shows the trial to be a deterioration. Clearly most of the rms errors have increased.Heights (**TABLE 3.5**) are typically 4-6% worse outside the tropics where they are ~2% worse. Temperatures (**TABLE 3.6**) are 2-4% worse generally, and winds (**TABLE 3.7**) are 3-4% worse at jet levels, which confirms the impact found for the smaller sample period, discussed in section 3.1. Previous parallel suite trials have used a 1% threshold to assess significant impact. It is apparent that with this criterion the 90 minute data cut-off has significantly degraded the forecast model performance.

3. 3 RMS ERRORS COMPARED TO ANALYSES -OVERALL SUMMARY

TABLES 3.9-3.13 summarise the percentage changes in rms errors for verification against analyses. A positive value shows the trial to be a deterioration. The verifying analyses were from the operational update. The T+6 results are only for the period 5-14 September since teething problems with the new verification system resulted in a loss of data after this period. The large increases in rms errors at T+6 reflect the impact of fewer data. In a proposed new schedule it would be necessary to repeat the previous (6h) assimilation cycle in order to include the missed observations and reduce this "background" error.

The changes in rms are somewhat larger than the degradations indicated from verification against radiosondes. For example the rms height errors at T+24 (**TABLE 3.9**) are 6-9% worse in area 2 whereas the increased errors were 4-6% from the observational comparison (**TABLE 3.5**). Similarly for the T+24 temperatures with 5-8% (**TABLE 3.10**) against 0-4% (**TABLE 3.6**). A similar pattern of increased detrimental impact is found for the extratropical Northern hemisphere and tropics, although there is a somewhat smaller worsening in the southern hemisphere (**FIG 3.6**).

For winds at T+24 (**TABLE 3.11**) there are large increases in rms vector wind errors (5-8%). The detrimental signal is again larger than was evident from the verification against radiosondes (**TABLE 3.7**). Short range wind forecasts are key operational products and this potential loss of accuracy cannot be countenanced without some compensating improvement from, for example, increased resolution.

Surface pressure (**TABLE 3.13** , **FIG 3.7**) also shows appreciable increases in rms errors, particularly for area 2 and in the Northern and Southern hemispheres, with typical changes

of 2-7%.

3. 4 Impact on composite NWP index

The composite NWP index (**TABLE 3.14**) is a measure of the of the forecast accuracy of the most important forecast products provided by the global model. It is composed of rms errors from verification against analyses. The index for month j is defined as

$$I_j = \frac{100}{\Sigma W_i} \sum W_i \frac{E_i}{\varepsilon_{ij}}$$

where E_i is the mean value of the i^{th} score during a reference year, ε_{ij} is the value of the score during the month in question and W_i is a chosen weighting reflecting the importance of forecasting this particular quantity.

Strictly 12 month running means of rms should be used but an estimate of the likely impact from the parallel trial can be made by substituting the operational and trial means[1] for ε_{ij} . **TABLE 3.14** shows the contribution of the individual components to the change in index (column 10). Clearly the 250hPa wind errors contribute the most to the overall loss in skill as measured by the index, with the short range (T+24,T+48) surface pressure errors in the Northern hemisphere also playing a large part. The total estimated change in index is in excess of 3 points (112.2 operational, 109.0 trial). This is a very large loss in performance. It should be contrasted with the latest major improvement to the model due to the introduction of orographic roughness and revised gravity wave drag which improved the index by 10 points from January 1995 to January 1996. It should also be noted that that change had a smaller impact on the upper level winds than the large degradation found in this trial. A drawback of the index is that it does not allow for timeliness and availability of the forecasts but it is based on the WMO CBS scores which major centres exchange and against which forecast centres are judged. The large degradations in the forecast components due to the 90 minute data cut-off could therefore not be accepted.

4. Subjective Assessment -trial period 23/08/95 - 24/09/95

Daily comparison of trial and operational forecasts during the parallel suite trial showed no changes of evolution in the northern hemisphere but there were significant differences in detail at T+72 onwards, some of which affected the forecast over the U.K.. Most of these differences were due to changes in position, depth and gradient of troughs and depressions and many could be traced back to the trial missing some late bogus data and Canadian ascents. The largest differences between analyses in the northern hemisphere were seen in the north-west Pacific, where TC bogussing was often added by forecasters just before

[1] Strictly the latitude band defining the tropics is at 20 degrees, but mean results are only conveniently available for 30 degrees here

the operational cut-off time of 3 hours 20 minutes, since the relevant advisories had only just been received.

The impact of the early cut-off was larger in the southern hemisphere, resulting in significant changes in detail by T+24 and some evolution changes at T+72 onwards. Whereas mean sea level pressure analysis differences exceeding 5hPa were very isolated in the northern hemisphere during the trial, many were seen in the southern hemisphere south of 60S, especially over Antarctica.

An analysis of the temps received after T+90 during the period 1st-23rd September showed that the following W.M.O. block numbers were most involved (**TABLE 4.1**).

TABLE 4.1

Block no.	Country	No. temps after T+90	Block no.	Country	No. temps after T+90
71	Canada	438	47	Korea/Japan	164
40	Arabia	213	43	India	162
30	Asia	194	29	Asia	161
42	India	191	24	Asia	159
72	U.S.A	185	23	Asia	157
16	Italy/Greece	177	87	Argentina	142
17	Turkey	164	52	China	138

Considering the forecast for the British Isles, the most important observations missed were the Canadian temps and an average of 19 were received too late for the early cut-off most days during September. The Canadian temps were received before T+90 on only 6 days out of 23 during the September trial period, but they were received by T+115 on 19 days. In particular, the late temps over Newfoundland were seen to have an impact in the subsequent forecast over the north Atlantic and British Isles. A large number of American ascents were also missed by the early cut-off, but these were mostly confined to three bad days, 5th,12th and 20th September. In the southern hemisphere, the late Argentinean ascents were seen to have an impact on the forecast jets and mean sea level pressure .

An analysis of the synops received after T+90 during the period 1st-23rd September showed that the following W.M.O. block numbers were most involved. As expected, the late observations are dominated by the southern hemisphere and the tropics (**TABLE 4.2**).

TABLE 4.2

Block no.	Country	No. synops after T+90	Block no.	Country	No. synops after T+90
83	Brazil	656	78	Caribbean	213
82	Brazil	433	85	ChileBolivia	202
40	Middle East	404	94 auto	Australia	1891
94	Australia	334	72 auto	America	251
67	Africa	226	89 auto	Antarctica	243

The overall subjective assessment of the global mean sea level pressure and 500hPa forecast differences strongly favoured the operational forecasts and the results are summarised in TABLE 4.3 below.

DIFFS	**N.HEM**	**N.HEM**	**N.HEM**	**DIFFS**	**S.HEM**	**S.HEM**	**S.HEM**
MSLP	**A%**	**B%**	**C%**	**MSLP**	**A%**	**B%**	**C%**
T+24	10	67	**23**	**T+24**	8	61	**31**
T+72	24	44	**32**	**T+72**	17	51	**31**
T+120	31	27	**42**	**T+120**	24	35	**41**
500hPa				**500hPa**			
T+72	19	19	**62**	**T+72**	33	26	**41**
T+120	30	16	**54**	**T+120**	25	29	**46**

TABLE 4.3. Subjective assessment of mean sea level pressure differences (>3hPa at T+24, >5hPa at T+72, >8hPa at T+120) and 500hPa differences (>6dm at T+72, >12dm)
Key : A - Trial better : B - Equal : C - Operational better

The impact of the early cut-off of data at T+90 upon forecasts in the north Atlantic, north-west Pacific and southern hemisphere is described below, with examples selected from 4 days of the trial.

a) DT 12Z 31st August

FIGURE 4.1 highlights the differences in data used between the trial and operational assimilations, with each black circle representing a temp, synop, ship or drifting buoy observation missed by the early cut-off at 90 minutes. Similarly, FIGURE 4.2 indicates the

number of aircraft reports missed by the trial assimilation. The difference in observations in the northern hemisphere was surprisingly large and included several North American temps and many north Atlantic aireps, ships and buoys.

In spite of the large discrepancies in data, the only noticeable analysis differences in the northern hemisphere were seen in the mean sea level pressure and 250hPa wind fields over Newfoundland. The mean sea level pressure analysis difference of 3hPa seen in **FIGURE 4.3c**, was the result of the early cut-off assimilation missing the St. John's temp (71801 - T+110) and also some bogus observations added by the forecasters at T+92 to fix the position of a depression centred just south of Newfoundland. A comparison of the trial and operational analyses in **FIGURES 4.3a/b** respectively, shows that the impact was just a small change in the position of the depression.

FIGURE 4.4c indicates that these late observations also resulted in slight differences between the trial and operational analyses of the 250hPa jets in the area of Newfoundland. These wind differences increased during the forecast resulting in significant changes in the T+24 jets across the north Atlantic. The trial jet core of 73ms^{-1} at 59N 25-30W, **FIGURE 4.5a**, was much stronger than the operational jet core of 59ms^{-1}, **FIGURE 4.5b**. In this case, the verifying analysis with 64ms^{-1}, **FIGURE 4.5d**, was between the two forecasts but slightly closer to the operational forecast.

Considering the large discrepancies in the data assimilated by the trial and operational analyses in the northern hemisphere , it was not surprising to see an impact on the T+120 forecast for the British Isles. The evolution of each forecast was similar, but there were important differences in detail. In the trial forecast, **FIGURE 4.6a,** the main depression was centred over northern Scotland with southwesterly winds across most of Scotland. In the operational forecast, **FIGURE 4.6b**, the depression was centred in the North Sea, with northerly winds over Scotland. The verifying analysis for 12Z 5th September, **FIGURE 4.6d**, favoured the operational forecast.

b) DT 12Z 3rd September

FIGURES 4.7 and 4.8 emphasise the large numbers of observations received too late for the early cut-off at T+90. On this particular day, the Canadian temps were received in time, but there were several American temps and aircraft reports, and also north Atlantic and Pacific aireps not included in the trial assimilation. Significant differences in the T+120 forecast over the U.K. and eastern Atlantic from this data time could not be traced back directly to any particular observations. However, the aircraft data probably had the biggest impact, since differences in the forecast polar jet across the Atlantic were evident by T+24.

The verifying analysis for 12Z 8th September, **FIGURE 4.9d**, shows a complex depression over the British Isles, with the main centre over Holland and a second centre over Scotland. There is also a deepening depression in the Atlantic at 45N 30W. Neither the trial or operational forecasts predicted the low pressure area over the U.K. accurately. The operational forecast, **FIGURE 4.9b**, was closer to the truth with a centre predicted over Scotland but it could be criticized for predicting too strong a westerly flow over England and Wales. The trial forecast, **FIGURE 4.9a**, predicted the centre to be much too far north, although the forecast pressure and winds for England and Wales were better.

FIGURE 4.10c indicates a big difference at T+120 in the forecast mean sea level

pressure between the trial and operational forecasts in the southern hemisphere south of Chile and the Falkland Islands. The important feature was a deep depression shown in the verifying analysis, **FIGURE 4.10d**, at about 60S 45W at 12Z 8th September. In the early cut-off forecast for T+120, **FIGURE 4.10a**, the depression was predicted too close to Chile and not deep enough by 12hPa. There were also errors in the operational forecast, **FIGURE 4.10b**, but it predicted a much better position and depth for the depression and also verified better over the Falkland Islands and Chile. **FIGURE 4.7** indicates that there were a large number of observations in the southern hemisphere which were received too late for the early cut-off.

c) DT 12Z 4th September

FIGURES 4.11 and 4.12 indicate the large number of extra observations for 12z 4th September which were used in the operational assimilation but were received too late for the early cut-off at T+90. In particular, the north Atlantic was likely to be data sensitive at this time, with a strong polar jet across the Atlantic and a deepening depression lying close to Newfoundland, and several key temps (71600, 71603, 71801 and 71816) and bogus observations for 45N 45W were received after T+90, thus missing the early cut-off. The operational forecast, **FIGURE 4.13,** predicted the depression to deepen by almost 30hPa as it crossed the Atlantic to threaten the southwest approaches by T+48. The lack of key observations had a marked impact on the deepening of the depression in the trial forecast shown in **FIGURE 4.14**. The trial depression was less deep at all forecast times, the difference increasing from 4hPa at analysis time to 12hPa by T+48. The verifying analyses for 12Z on the 5th, 6th and 7th September, shown in **FIGURE 4.15**, indicate that the operational depression deepened too quickly in the first 24 hours but was more accurate at T+48 and T+72.

FIGURE 4.16 shows the impact of the differences in upper air data on the analysis of the 250hPa polar jet across the Atlantic at 12Z 4th September. In particular, the operational jet was $4ms^{-1}$ stronger over Newfoundland and there were also significant differences at 40-50N 30W on the southern boundary of the jet. At T+24, **FIGURE 4.17c** indicates a large difference between the trial and operational northerly jets to the west of Ireland and Biscay. The operational jet core , **FIGURE 4.17b**, with a maximum of $79ms^{-1}$ was much stronger than the trial jet maximum of $66ms^{-1}$, **FIGURE 4.17c**. The verifying analysis for 12Z 5th September, **FIGURE 4.17d**, was closer to the trial but weaker than both forecasts, with a peak of only $58ms^{-1}$.

d) DT 12Z 18/09/95 - Typhoon Polly in northwest Pacific.

Several large differences in mean sea level pressure between operational and trial analyses in the northwest Pacific were due to TC bogussing being added just before the operational cut-off time of 3 hours 20 minutes. This particular example shows the impact of bogussing upon the forecast of Typhoon Polly, as it moved northeastwards close to Japan during the period 19th-21st September.

FIGURE 4.18 compares the forecast and actual tracks of Typhoon Polly from 12Z 15th September. There was very little to choose between the forecasts, with both versions predicting a mainly northerly track, keeping the typhoon too close to Japan. The main impact of the bogus data was seen in the depth of the depression. The operational forecast of the

movement and depth of Typhoon Polly is shown in **FIGURE 4.19**. The depth of the operational depression remained steady at around 985hPa. In the trial forecast, **FIGURE 4.20**, the track was almost identical but the typhoon was less deep at all times.

e) Conclusions from the subjective assessment

The overall subjective assessment of the global mean sea level pressure and 500hPa forecast differences strongly favoured the operational forecasts .

Considering the forecast for the British Isles, the most important observations missed by the early cut-off run were the Canadian temps, and in particular, the late temps over Newfoundland were seen to have an impact in the subsequent forecast over the north Atlantic and British Isles.

6. CONCLUSIONS

This study has shown that a 90 minute data cut-off is unacceptable. The main findings are :

- only 50-60% of the total data available by T+200min has been received before T+90min
- asynoptic data such as AMDARs, AIREP and DRIBUs are effectively continuously received and any reduced cut-off is bound to reduce the total data used
- Canadian sonde observations usually arrive later than 90 minutes and are the most important missing data for British Isles forecasts
- aviation wind forecasts are particularly adversely affected; when a 90 minute cut-off is used, typically half the improvement over the no observations run obtained with the operational cut-off is lost.
- The loss of forecast accuracy is somewhat greater when verified against analyses than against radiosondes, although comparison of winds with aircraft observations shows similar large impacts.
- The composite NWP index, based on verification against analyses, is estimated to decline by over 3 points

The parallel suite results show that the loss of accuracy resulting from a 90 minute data cut-off is unacceptable. The objective verification shows that the losses are larger than the benefits gained from several recent model changes. Further studies of data receipt volumes should guide the further tests, which should have a cut-off of around 120 minutes in order to deliver products for aviation and UK detailed model guidance in time.

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FIGURES

Figure 2.1 Percentage data received between T+90 and T+200 for 12UTC. Observation types AMDAR, AIREP and SYNOP
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Figure 2.9 Number of SHIP data received before T+90 and every 5 minutes till T+200 for 12UTC.
Figure 2.10 Number of SHIP TEMP data received before T+90 and every 5 minutes till T+200 for 12UTC.
Figure 2.11 Number of PILOT data received before T+90 and every 5 minutes till T+200 for 12UTC.

for 12UTC.
Figure 2.12 Number of DRIBU data received before T+90 and every 5 minutes till T+200 for 12UTC.
Figure 2.13 Number of Ocean Weather ship data received before T+90 and every 5 minutes till T+200 for 12UTC.
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Figure 3.4 Vertical profile of mean rms temperature errors of T+12 and T+24 forecasts verified against radiosondes for the period 5-14/09/95; operational (T+200minutes)- full line, trial (T+90minutes) -dashed and "no obs" (forecast from T-6 analysis) -dotted, for area 2, NH to 30N
Figure 3.5 Mean rms temperature errors of T+12 and T+24 forecasts verified against aireps for the period 5-14/09/95; operational (T+200minutes)- full line, trial (T+90minutes) -dashed and "no obs" (forecast from T-6 analysis) -dotted, for area 2, NH to 30N
Figure 3.6 Vertical profile of mean bias and rms temperature errors of T+24 forecasts verified against update analyses for the period 5-24/09/95; operational (T+200minutes)- full line, trial (T+90minutes) -dashed, for area 2, NH to 30N tropics 30N-30S and SH from 30S
Figure 3.7 Mean bias and rms of forecasts of mean sea level pressure verified against update analyses for the period 5-24/09/95; operational (T+200minutes)- full line, trial (T+90minutes) -dashed, for area 2, NH to 30N tropics 30N-30S and SH from 30S
Figure 4.1 Positions of temps, synops, ships and buoys received between T+90 and T+200 minutes after 12Z 31/08/95
Figure 4.2 Positions of aireps, amdars and acars received between T+90 and T+200 minutes after 12Z 31/08/95

Figure 4.3 Mean sea level pressure analysis for 12Z 31/08/95 over Newfoundland from (a) parallel suite trial (b) operational suite (c) trial - operational differences

Figure 4.4 250hPa wind analysis for 12Z 31/08/95 over Newfoundland from (a) parallel suite trial (b) operational suite (c) trial - operational differences

Figure 4.5 250hPa wind forecast for T+24 over north Atlantic DT12Z 31/08/95 from (a) parallel suite trial (b) operational suite (c) trial - operational differences (d) Verifying 250hPa wind analysis for 12Z 01/09/95 over the north Atlantic from operational suite

Figure 4.6 Mean sea level pressure forecast for the British Isles for T+120, DT12Z 31/08/95 verifying at 12Z 05/09/95 from : (a) the parallel suite trial (b) operational suite (c) trial - operational differences (d) verifying analysis for 12Z 05/09/95

Figure 4.7 Positions of temps, synops, ships and buoys received between T+90 and T+200 minutes after 12Z 03/09/95

Figure 4.8 Positions of aireps, amdars and acars received between T+90 and T+200 minutes after 12Z 03/09/95

Figure 4.9 Mean sea level pressure forecast for the British Isles and eastern Atlantic for T+120, DT12Z 03/09/95 verifying at 12Z 08/09/95 from : (a) the parallel suite trial (b) operational suite (c) trial - operational differences (d) verifying analysis for 12Z 08/09/95

Figure 4.10 Mean sea level pressure forecast for the south Atlantic for T+120, DT12Z 03/09/95 verifying at 12Z 08/09/95 from : (a) the parallel suite trial (b) operational suite (c) trial - operational differences (d) verifying analysis for 12Z 08/09/95

Figure 4.11 Positions of temps, synops, ships and buoys received between T+90 and T+200 minutes after 12Z 04/09/95

Figure 4.12 Positions of aireps, amdars and acars received between T+90 and T+200 minutes after 12Z 04/09/95

Figure 4.13 Operational mean sea level forecast from DT12Z 04/09/95 showing: (a) analysis near Newfoundland (b) T+24 forecast central Atlantic (c) T+48 forecast for British Isles (d) T+72 forecast for the British Isles

Figure 4.14 Trial mean sea level forecast from DT12Z 04/09/95 showing: (a) analysis near Newfoundland (b) T+24 forecast central Atlantic (c) T+48 forecast for British Isles (d) T+72 forecast for the British Isles

Figure 4.15 Mean sea level pressure analyses for (a) 12Z 05/09/95 (b) 12Z 06/09/95 (c) 12Z 07/09/95

Figure 4.16 250hPa wind analysis for 12Z 04/09/95 over the Atlantic from (a) parallel suite trial (b) operational suite (c) trial - operational differences

Figure 4.17 250hPa wind forecast for T+24 over north Atlantic DT12Z 04/09/95 from (a) parallel suite trial (b) operational suite (c) trial - operational differences (d) Verifying 250hPa wind analysis for 12Z 05/09/95 over the north Atlantic from operational suite

Figure 4.18 Forecast tracks of Typhoon Polly in the northwest Pacific from 12Z 15th to 12Z 21st September 1995

Figure 4.19 Operational mean sea level forecast from DT12Z 18/09/95 in the northwest Pacific showing the position of Typhoon Polly: (a) analysis south of Japan (b) T+24 forecast verifying 12Z 19/09/95 (c) T+48 forecast verifying 12Z 20/09/95 (d) T+72 forecast verifying 12Z 21/09/95

Figure 4.20 Trial mean sea level forecast from DT12Z 18/09/95 in the northwest Pacific showing the position of Typhoon Polly: (a) analysis south of Japan (b) T+24 forecast verifying 12Z 19/09/95 (c) T+48 forecast verifying 12Z 20/09/95 (d) T+72 forecast verifying 12Z 21/09/95

APPENDIX A

DATA RECEIPT AT 00UTC FOR 1-23 SEPTEMBER

The results given in section 2 on data receipt times and volumes were for 12UTC and directly relevant to the parallel suite trial. The same analysis was repeated for 00UTC to check for any significant differences (**TABLE A.1** cf **TABLE 2.1**), which are noted here.

For radiosondes (**FIG A.1**) the local peak for receipt of NH data is again found at around 110-115 minutes. There are significantly more AMDAR reports at 00UTC than 12UTC (**FIG A.2** cf **FIG 2.4**) but rather fewer AIREPs (**FIG A.3** cf **FIG 2.5**) . For the tropics and SH there are peaks at 120-125 minutes and 180-185 minutes. A sensible choice of cut-off should therefore follow one of the local peaks.

There are rather fewer SATOBs (**FIG A.4** cf **FIG 2.6**) than at 12UTC, but there is a peak in receipt at 140-145 minutes . Again the cut-off should be chosen following this peak if possible. There are approximately double the number of pilot reports (**FIG A.5** cf **FIG 2.11**) , with a peak for the NH around 140-145 minutes.

APPENDIX B

We are grateful to Julian Heming, FS9, for providing the following tropical cyclone forecast track verification.

Key :

No. verified - Number of forecasts verified for each time
D.P.E - Direct Positional Error in kilometres
%increase - % increase in PS error compared to Operational.
PS - Parallel Suite

Forecast Error comparison for North Atlantic

	T+0	T+24	T+48	T+72	T+96	T+120
No. Verified	49	36	33	26	19	15
Oper DPE	44	123	201	279	382	449
PS DPE	56	123	197	275	376	478
% Increase	27.2	0.0	-2.0	-1.4	-1.6	6.4

Overall increase in PS analysis/forecast error: 7.3%

Forecast Error comparison for North-East Pacific

	T+0	T+24	T+48	T+72	T+96	T+120
No. Verified	21	16	11	6	3	2
Oper DPE	51	199	276	297	361	474
PS DPE	54	200	268	304	358	379
% Increase	5.9	0.5	-2.9	2.4	-0.8	-20.0

Overall increase in PS analysis/forecast error: 1.2%

Forecast Error comparison for North-West Pacific

	T+0	T+24	T+48	T+72	T+96	T+120
No. Verified	43	31	22	12	7	4
Oper DPE	59	172	322	418	583	831
PS DPE	82	203	340	512	566	666
% Increase	39.0	18.0	5.6	22.4	-2.9	-19.9

Overall increase in PS analysis/forecast error: 21.2%

Comments

Advancing the cut-off time to 90 minutes resulted in an increase in global TC analysis and forecast positional errors of 11.3% on average. The parallel suite runs dissipated TCs earlier than the operational runs on more occasions than the reverse.

Differences were due to fewer observations (real and bogus) being assimilated in the vicinity of TCs. In the Atlantic and north-east Pacific, TC advisories used to create bogus observations in the 12Z forecast run were received well before T+90, so differences in these two areas could be attributed to differences in real observations only. However, in the north-west Pacific, TC bogussing was often carried out just before the operational cut-off time of 3 hours 20 minutes, because the relevant advisories had only just been received. Hence in this area TC bogus observations may not have been used in the parallel suite runs. The statistical breakdown shows that in the north-west Pacific there was a larger increase in forecast errors in the parallel suite runs than in the other two areas.

TABLE 2.1

GLOBAL MODEL 1-23 Sep 1995 Data Volumes by Receipt Time

Ob Type	Hemisphere	<VT+90	90-95	95-100	100-105	105-110	110-115	115-120	120-125	125-130	130-135	135-140	140-145	145-150	150-155	155-160	160-165	165-170	170-175	175-180	180-185	185-190	190-195	195-200
AMDAR	North	16604	427	1074	778	366	987	1128	367	666	868	436	786	971	1184	1344	808	872	612	1681	812	630	735	370
	Tropical	6311	47	99	119	64	178	128	805	139	97	49	117	184	118	43	32	58	54	67	443	92	48	9
	South	10415		5			39		828	28		2		75		9			8		227	4	4	
AIREP	North	21711	254	1076	226	283	1136	476	533	1539	1101	1403	1627	335	418	1076	249	306	961	212	492	1075	1123	1111
	Tropical	3317	4	118	8	2	145	16	140	272	48	252	155	4	26	201	8	30	218	28	153	437	95	148
	South	565	14	4	6		4	18	29	32	20	2	2		2	10	2	8			39	46	6	
Auto Buoy	North	2571	1		6	4	4	4	3				16		2	16							5	
	Tropical	462	1		1								2	2			2		2					
	South	2			1																			
SHIP	North	5553	58	30	66	22	61	47	112	39	66	26	60	46	45	24	36	43	21	32	42	21	41	36
	Tropical	4152	27	19	71	14	41	51	198	13	36	19	32	38	27	16	42	28	23	16	66	16	35	5
	South	634	9	4	5	1	10	6	22		1	1	2	7			5	5	3	4	16	2	3	4
DRIFTER	North	7254	313	142	354	176	282	245	238	286	206	149	298	168	258	309	297	194	183	180	173	122	182	154
	Tropical	2478	148	57	148	59	76	130	92	82	140	75	186	48	79	115	146	45	233	45	38	49	87	33
	South	1653	99	26	71	85	91	120	94	80	121	65	105	21	154	213	160	46	176	47	33	105	106	39
OWS	North	129	1			1	1			16	1	6	14	2		1	1	1		2				1
	Tropical																							
	South																							
SYNOP	North	65794	176	452	196	170	144	72	22	38	25	30	195	54	88	185	64	39	75	53	58	27	32	37
	Tropical	29414	358	484	274	250	271	305	218	105	112	292	152	156	187	214	85	289	99	78	55	88	39	31
	South	9801	21	29	30	26	32	25	62	13	9	656	552	10	46	99	15	296	62	139	110	51	22	20
SATEM	North	3402	110	389	188	99	162	68	145	74	43	78	23	70	32	151	4	53	45	82	18	1	101	54
	Tropical	3957	122	362	179	86	175	49	153	70	41	131	37	102	33	151	34	77	59	99	42	2	84	55
	South	2821	93	268	163	75	112	56	140	63	45	117	45	79	34	62	40	59	54	84	47	40	41	67
SATOB	North	5255	321		163	196	152	32	82	191	263		616	445	164	347	38	90		78	249	146		37
	Tropical	29062	2462	344	3389	2378	1578	1460	1491	3530	4024	1059	4630	4097	672	2673	1147	634	848	1987	1732	1287		780
	South	7242	1065	47	1200	1151	137	419	101	218	456	52	1668	1384	198	346	98	68	201	172	325	461		85
TEMP A	North	4335	636	534	282	150	653	172	141	114	264	77	122	113	134	70	28	61	93	17	72	16	13	6
	Tropical	1395	168	69	19	22	27	27	94	48	237	96	120	139	98	111	26	68	60	88	59	52	61	23
	South	289	82	19	5	6	12	16	54	7	10	9	5	9	10	9	3	4	5	3	2	10	3	1
TEMP B	North	21	3	26	6	7	17	18	11	7	5		6	4	1	5	1	17	5	1		3	1	
	Tropical	25	2	9	19	1	2	3	1	1	3	15	6	2	1	3	2	7	3	1	3	8	2	
	South	1		6	18	8	3	6		1		1				2	2			1		1		
SHIP TEMP A	North	92	20	3	6	6	2	4	4	4	5		2		2	2	1	2	1	1		1		1
	Tropical	59	13	2			2	1	1	3	8	3		1	4	21	4	4	1	2				
	South																							
SHIP TEMP B	North	2				1													1					
	Tropical	3		1																				
	South																							
PILOT A	North	332	6	5	5	3	3	4			2	14	1		3	3		1	1		1	1		
	Tropical	1904	37	31	47	23	43	48	35	12	29	8	17	39	17	21	19	11	10	2	5	9	9	7
	South	631	2	1	24	3	52	25	4	3	2	2	2		3	3	2		4	1	1	1	1	2
PILOT B	North	106	27	8	5	2	1	21	38	14				1	1	2	2	1					1	
	Tropical	215	4	21	27	8	3	13	28	12	5		10	5	3	13	1	2	2			3	1	
	South	9			1																			

TABLE 3.1

% RMS CHANGE FOR PERIOD
Mean period 950905 to 950914
Verification against sondes
wind

T+	12 trial	12 NoObs
AREA 2		
850	0.2	4.2
700	0.5	4.8
500	2.4	6.9
400	1.5	8.4
300	0.7	9.9
250	1.1	9
200	-1.9	6.1
100	-0.6	1.4
N HEM TO 30N		
850	1.2	5.3
700	2.2	6.3
500	3.1	8.2
400	3.2	9.8
300	3.1	11.4
250	4.1	11.4
200	3.6	12.7
100	2.6	2.3
TROPICS 30N-30S		
850	2.8	5.3
700	3.2	8.3
500	3.8	8.6
400	3	7.4
300	4.4	8.8
250	2.9	5.9
200	5.5	7.3
100	2.9	4.3
S HEM FROM 30S		
850	4.3	6.1
700	4.2	8.3
500	6.9	10.7
400	8.4	12.2
300	1.4	3
250	1.1	4.4
200	-1.5	0.6
100	2	3.8

% RMS CHANGE FOR PERIOD
Mean period 950905 to 950914
Verification against sondes
wind

T+	24 trial	24 NoObs
AREA 2		
850	1.1	4.3
700	0.9	4.5
500	3.3	8.2
400	2.6	9.6
300	2.9	10.2
250	3.6	12
200	2.8	13.6
100	2	1.2
N HEM TO 30N		
850	1.1	4.3
700	1.1	5.4
500	2.6	8.7
400	2.9	9.6
300	3.3	9.6
250	3.9	10.8
200	4.1	14
100	2.3	5.7
TROPICS 30N-30S		
850	1.8	4.7
700	2.1	5.4
500	2.7	5.6
400	1.3	3.2
300	1.8	2.9
250	2.1	5
200	2.5	3.9
100	2.1	3.1
S HEM FROM 30S		
850	0.3	7.6
700	0.7	4.3
500	1.6	2.8
400	2.6	6.2
300	1.7	4.3
250	2.7	5
200	2.3	5.6
100	1.3	0.3

TABLE 3.2

% RMS CHANGE FOR PERIOD
Mean period 950905 to 950914
Verification against sondes
temperature

T+	12 trial	12 NoObs
AREA 2		
850	3.8	12.8
700	3.6	10.9
500	0.9	5.2
300	3	14.1
250	0	6
200	-1.6	2.7
100	-2.5	0.8
50	2.8	10.5
N HEM TO 30N		
850	5.7	14.3
700	4.1	11.5
500	3.4	10.1
300	5.2	12.7
250	3.8	13.3
200	2.3	6.4
100	0.6	3.1
50	10.1	9.1
TROPICS 30N-30S		
850	2.9	8
700	0.8	7.2
500	0	2.6
300	0	5.4
250	2.5	11.6
200	0.8	10.5
100	0.4	2.6
50	1.9	4.2
S HEM FROM 30S		
850	3.8	4.3
700	0.6	9.7
500	-1.2	3.1
300	2.9	7.8
250	-1.4	1.4
200	-1.5	0.5
100	0.5	3.1
50	1.8	7.6

% RMS CHANGE FOR PERIOD
Mean period 950905 to 950914
Verification against sondes
temperature

T+	24 trial	24 NoObs
AREA 2		
850	2.6	9.9
700	2.3	8.6
500	4.7	8.6
300	1.4	11.6
250	-1	8.9
200	0	3.7
100	0	5.8
50	0.6	8.3
N HEM TO 30N		
850	2.4	10.7
700	2.1	9.1
500	3	10.4
300	3.2	12.7
250	1.6	13.4
200	3	10.7
100	0.6	5
50	8.6	10.4
TROPICS 30N-30S		
850	-0.6	7.6
700	3.2	8.7
500	2.4	4
300	1.8	10.6
250	3.1	15.4
200	2.1	11.6
100	0	5.5
50	5	11.4
S HEM FROM 30S		
850	3.7	5.4
700	7.5	16.1
500	2.3	1.1
300	-0.5	5.3
250	0.4	6.1
200	5.7	7
100	2.5	9
50	-0.6	8.3

TABLE 3.3

% RMS CHANGE FOR PERIOD
Mean period 950905 to 950914
Verification against aireps
temperature

T+	12	12
.	trial	NoObs
AREA 2		
300	0.6	6.8
250	2.7	2.7
200	5.4	8.6
N HEM TO 30N		
300	3.6	11.3
250	1.0	4.5
200	3.0	9.9
TROPICS 30N-30S		
300	6.3	6.9
250	4.9	5.9
200	-0.5	2.5
S HEM FROM 30S		
300	-1.2	3.5
250	-5.3	-1.9
200	1.0	6.2

% RMS CHANGE FOR PERIOD
Mean period 950905 to 950914
Verification against aireps
temperature

T+	24	24
.	trial	NoObs
AREA 2		
300	-0.8	-4.1
250	0.9	1.8
200	1.8	5.0
N HEM TO 30N		
300	-0.4	-2.1
250	0.9	4.8
200	1.2	10.2
TROPICS 30N-30S		
300	0.5	3.1
250	0.0	-2.3
200	2.2	12.0
S HEM FROM 30S		
300	2.9	-1.9
250	-1.7	2.4
200	-6.3	-9.1

TABLE 3.4

% RMS CHANGE FOR PERIOD
Mean period 950905 to 950914
Verification against aireps
wind

T+	12	12
.	trial	NoObs
AREA 2		
300	1.1	5.6
250	4.1	8.2
200	4.1	8.6
N HEM TO 30N		
300	3.8	10.9
250	2.2	8.0
200	4.9	10.4
TROPICS 30N-30S		
300	2.0	5.3
250	3.5	7.8
200	2.3	7.8
S HEM FROM 30S		
300	0.7	9.4
250	0.1	5.3
200	0.0	4.1

% RMS CHANGE FOR PERIOD
Mean period 950905 to 950914
Verification against aireps
wind

T+	24	24
.	trial	NoObs
AREA 2		
300	5.5	13.1
250	2.5	9.1
200	2.0	6.4
N HEM TO 30N		
300	5.0	12.8
250	3.9	9.4
200	2.3	6.9
TROPICS 30N-30S		
300	-0.5	5.3
250	0.5	5.2
200	1.5	4.6
S HEM FROM 30S		
300	-3.1	-10.5
250	0.8	15.9
200	-0.8	-0.7

TABLE 3.5

% RMS CHANGE FOR PERIOD
Mean period 950905 to 950924
Verification against sondes
height

T+	24	48	72	96	120
AREA 2					
850	2.8	5.7	3.6	0.9	2
700	3.2	5.7	4.2	2.8	3
500	4	5.2	4.4	4.6	4.8
300	5.1	4.3	4.1	5	5.4
250	4.9	3.9	4.3	5	5.3
200	2.5	4	4.9	5.6	5.4
100	-1.8	0.5	2.8	3.8	1.7
50	-1.5	-0.8	1.3	1.7	0.6
N HEM TO 30N					
850	1.6	3.8	2.3	2.3	1.9
700	2.6	3.9	3.2	3.8	2.8
500	3.4	4.1	4.1	5	4
300	4.7	3.7	3.9	3.8	4
250	4.4	3.6	3.6	3.6	3.9
200	3.2	2.9	2.8	3.7	3.5
100	1.9	2.3	1.8	3	1.8
50	7.1	6.9	4.1	5.3	3.3
TROPICS 30N-30S					
850	-0.3	3.4	1.6	1.7	-0.6
700	0.6	3.2	1.4	1.7	-1.2
500	1.8	2.2	1.4	0.8	-1
300	1.2	2.2	1.9	2.2	0.3
250	1.3	2.1	1.6	1.9	-0.1
200	1.5	1.6	1.2	1.5	0
100	1.1	1.3	0.5	2	0.8
50	4.4	4.4	1.8	2.8	2.6
S HEM FROM 30S					
850	1.8	4.9	1.8	3.6	2.8
700	3.6	7.6	1.4	3	3.5
500	4.9	7.6	0.5	1.2	2
300	8.4	5.9	1.7	1.4	1.1
250	10	5.9	2.5	1.7	1
200	9.5	5.6	2.9	2.1	2.3
100	6	2.2	4.2	0.3	3.1
50	5	0.9	1.7	-1	3.3

TABLE 3.6

% RMS CHANGE FOR PERIOD
Mean period 950905 to 950924
Verification against sondes
temperature

T+	24	48	72	96	120
AREA 2					
850	3.4	3.2	1.7	0.7	3.4
700	3.1	3.7	2	4.1	4.9
500	2.4	3.6	1.4	3.1	5
300	2.7	1.6	2.2	1.9	1.1
250	-0.5	0.9	0	4	3.4
200	1.5	0	0	2.7	3.1
100	0.7	0.6	1.1	2.9	3.4
50	3.9	3.6	3.8	5.9	6.2
N HEM TO 30N					
850	3	2.9	3.3	3.4	3.5
700	2.8	2.3	2.8	4	4.1
500	3.7	1.8	2.4	2	3.4
300	3.7	2.5	1.7	1.1	1.4
250	2.1	2.2	0	1.7	2.1
200	3.1	2.1	1.7	1.8	2.4
100	0.6	1.2	1.6	2.4	2.2
50	13.7	8.4	5.1	6.7	4.8
TROPICS 30N-30S					
850	1.7	2.2	1	-0.5	0.9
700	3.2	1.4	2	2.5	0.6
500	1.6	0.8	2.1	1.3	0
300	0.9	3.8	2.8	1.3	0
250	3	3	1.1	1.6	-0.5
200	2	-0.6	2.2	2	1.9
100	-0.4	-1.7	-1.3	-1.3	-1.6
50	6.5	4	2.7	2.3	2.8
S HEM FROM 30S					
850	3.3	5.7	2.7	-1.6	-0.7
700	4.9	2.3	-0.3	0.6	3.1
500	4.1	2	0.4	-1.3	3.7
300	1	3.1	-1.6	1.5	1.8
250	1.3	2.2	-1	2.1	1.2
200	3.1	0.7	1.2	4.1	1
100	3.2	3	3.5	1.2	3.3
50	1.7	0.6	-0.5	-1.3	0.9

TABLE 3.7

% RMS CHANGE FOR PERIOD
Mean period 950905 to 950924
Verification against sondes
wind

T+	24	48	72	96	120
AREA 2					
850	1.1	1.9	2.2	1.4	4.4
700	1.3	1.3	1.9	3.1	4.6
500	2.4	2.8	1.4	3.8	5.8
400	2.7	2.7	1.5	3.2	5.8
300	3.3	1.5	0.9	4	5.2
250	3.3	1.4	1.4	4.3	5.2
200	3	2.1	1.6	4.5	5.6
100	1.1	0.5	1.5	3.2	4.5
N HEM TO 30N					
850	1.1	1.7	1.8	1.7	2.1
700	1.3	1.3	1.5	2.8	3.3
500	2.6	2.5	1.8	4.3	4.5
400	3.6	2.6	2.4	3.8	3.9
300	4.1	2.6	2.2	3.4	3.5
250	4.2	2.8	2.3	3.7	3.6
200	3.2	3	2.6	4.3	3.8
100	2.5	1.8	2	2.9	1.8
TROPICS 30N-30S					
850	2.6	1.2	0.9	0.2	0
700	1.6	1.8	1.2	-0.8	0
500	2.2	1.4	1.6	0.9	1.5
400	2.2	1.8	1.2	0.5	2.5
300	2.9	2.7	2.5	1.1	4.1
250	3.3	3.4	3.1	0.5	3.3
200	3.4	2.4	3.1	1.5	3.1
100	2	0.4	0.8	1.9	1.9
S HEM FROM 30S					
850	-0.3	1.1	0.7	0.7	6.6
700	0.7	0.5	1.9	3.5	1.7
500	2.7	0.4	3.3	3.7	-1.1
400	3.5	0.8	2.3	4.3	1.8
300	3.2	1.9	3.2	3.1	1.3
250	3.9	1.6	2.9	2.7	0.4
200	3	3.1	4.6	2	0.9
100	1.1	1.3	1.5	4.1	1.4

TABLE 3.8

% RMS CHANGE FOR PERIOD
Mean period 950905 to 950924
Verification against sondes
rel humidity

T+	24	48	72	96	120
AREA 2					
850	0.9	0.8	0.7	1.2	1.2
700	1	1	1.2	1.7	-0.2
500	0.9	0.1	2	2.3	0.4
N HEM TO 30N					
850	1.4	1.1	0.9	0.9	1.4
700	1	1.5	1.9	1.3	0
500	1.5	0.5	2.4	1.8	0.6
TROPICS 30N-30S					
850	2.1	0.6	0.6	-0.2	-0.2
700	2	0.8	0.8	-0.1	0.5
500	4	2.2	1.4	0	0.7
S HEM FROM 30S					
850	2.9	3.8	1.7	0.8	-1.4
700	2.9	-1.2	1.1	0.5	2.7
500	7.1	0.7	-1.6	0.8	2.1

TABLE 3.9

% RMS CHANGE FOR PERIOD
Mean period 950905 to 950924
Verification against analyses
height

T+	6	24	48	72	96	120
AREA 2						
850	8.2	6.3	5.7	2.9	3.3	4.5
700	13.8	6.6	5.7	3.7	4.6	4.8
500	15.5	7.4	5.8	4.2	5.5	4.5
300	18.2	8.1	5.7	3.6	5.4	3.9
250	19.7	8.2	5.2	3.2	5.3	3.7
200	22.5	8.9	4.6	3.4	5.8	4.0
100	34.2	5.7	2.0	4.0	7.9	4.9
50	-6.9	5.7	-0.9	2.6	2.7	-0.7
N HEM TO 30N						
850	8.5	2.0	3.8	3.5	4.5	2.6
700	17.9	2.5	3.5	3.9	4.8	3.6
500	25.2	3.4	3.6	3.7	5.1	4.2
300	27.2	5.2	3.8	3.3	4.8	4.0
250	26.4	4.8	3.4	2.8	4.5	3.6
200	25.3	3.9	2.6	2.5	4.5	3.4
100	26.4	3.0	2.1	2.6	5.5	2.7
50	-7.2	3.1	0.3	-0.6	2.3	-1.2
TROPICS 30N-30S						
850	1.7	-2.4	2.1	-0.8	1.0	1.7
700	13.8	-1.0	2.5	0.1	1.6	0.4
500	22.6	1.0	3.3	1.5	2.6	0.9
300	20.4	3.6	5.5	3.6	4.1	2.3
250	19.8	5.2	5.1	3.5	3.8	2.2
200	18.8	5.6	3.7	3.2	3.3	2.1
100	25.5	4.1	3.1	2.9	3.3	1.5
50	13.3	-1.8	2.6	0.1	2.7	0.5
S HEM FROM 30S						
850	12.1	2.5	3.2	3.7	2.9	3.6
700	18.3	2.7	3.6	4.0	2.9	3.1
500	25.5	3.3	3.7	4.3	3.3	2.2
300	23.5	3.2	3.1	3.8	2.7	1.8
250	24.0	2.7	3.0	3.6	2.6	1.8
200	25.0	2.7	3.4	3.6	2.7	2.0
100	29.4	3.8	3.0	4.2	1.7	2.3
50	23.3	4.2	2.5	3.4	0.9	2.7

TABLE 3.10

% RMS CHANGE FOR PERIOD
Mean period 950905 to 950924
Verification against analyses
temperature

T+	6	24	48	72	96	120
AREA 2						
850	24.4	5.8	4.2	1.7	2.5	2.0
700	19.0	7.4	6.8	4.5	3.9	3.8
500	24.4	7.3	5.1	2.2	3.9	3.0
300	21.2	4.7	3.2	1.7	1.5	0.7
250	15.1	7.6	1.5	0.0	3.9	3.7
200	21.3	7.9	2.9	0.0	2.1	2.2
100	3.9	4.3	1.8	1.4	4.3	2.6
50	-1.7	0.0	-3.2	-0.9	5.0	4.0
N HEM TO 30N						
850	36.6	4.4	2.9	2.2	3.3	2.4
700	30.0	4.0	4.0	3.0	3.6	2.4
500	30.8	4.2	2.7	2.5	2.8	2.0
300	25.9	4.8	2.7	1.3	1.2	1.4
250	21.0	6.3	2.7	0.4	2.6	2.2
200	36.7	6.6	3.2	2.0	2.3	2.5
100	8.2	5.3	2.7	2.1	3.4	2.9
50	5.9	3.5	-2.4	-0.7	0.6	0.0
TROPICS 30N-30S						
850	23.1	3.7	2.4	0.7	0.6	0.6
700	22.2	6.8	4.2	1.9	2.2	1.9
500	27.6	6.5	4.3	3.3	2.9	2.6
300	26.7	6.1	3.0	0.8	2.1	1.3
250	21.1	3.9	0.9	0.8	0.7	1.3
200	34.5	5.6	0.9	1.5	0.7	0.6
100	18.9	0.0	0.0	-1.7	1.5	0.7
50	7.3	0.0	1.1	2.8	0.0	2.2
S HEM FROM 30S						
850	21.6	1.8	4.0	2.3	-0.3	-0.7
700	18.4	0.6	3.3	1.9	0.5	0.2
500	22.2	4.2	2.2	2.8	0.9	1.0
300	25.4	2.7	2.0	1.7	2.3	0.7
250	26.7	3.6	3.0	2.9	2.5	1.4
200	23.7	2.6	1.7	1.9	1.4	1.2
100	22.0	3.6	2.8	3.4	3.2	3.4
50	19.1	3.6	1.1	2.2	3.2	3.6

TABLE 3.11

% RMS CHANGE FOR PERIOD
Mean period 950905 to 950924
Verification against analyses
wind

T+	6	24	48	72	96	120
AREA 2						
850	12.6	5.3	2.2	2.6	3.1	4.4
700	19.3	5.7	2.5	3.0	4.1	4.9
500	19.3	6.8	2.7	2.6	4.5	4.9
400	22.0	7.7	2.3	2.1	3.7	4.3
300	19.1	7.8	2.0	1.2	3.2	3.8
250	14.7	6.7	2.6	1.6	3.6	3.6
200	13.1	7.0	3.4	1.9	4.5	4.5
100	22.3	6.1	2.4	2.2	5.2	3.3
N HEM TO 30N						
850	18.3	1.8	1.2	1.3	2.4	3.0
700	30.0	2.9	1.4	1.1	3.2	3.2
500	32.3	5.5	2.1	2.1	4.0	3.6
400	34.5	6.4	2.7	2.4	3.5	3.2
300	28.4	6.6	3.0	2.3	2.8	2.8
250	22.7	5.7	3.4	2.4	2.9	2.5
200	21.4	4.8	3.7	2.8	3.2	2.7
100	38.9	5.3	3.6	2.8	3.7	2.3
TROPICS 30N-30S						
850	16.7	0.8	1.2	1.0	0.4	1.0
700	33.3	4.7	3.1	1.9	1.7	1.3
500	31.3	5.6	3.2	2.1	2.2	1.5
400	31.7	6.1	4.2	3.1	2.7	2.2
300	31.2	6.9	4.0	3.5	2.5	1.9
250	30.2	6.6	3.2	2.9	1.8	1.5
200	33.1	6.2	2.7	2.8	2.1	1.6
100	50.0	5.9	4.5	3.0	2.6	1.6
S HEM FROM 30S						
850	13.7	4.3	3.1	3.1	1.9	2.6
700	20.9	3.8	3.2	4.0	2.6	2.7
500	23.9	5.8	3.8	4.1	3.1	1.7
400	27.6	6.3	4.1	4.2	2.7	1.6
300	28.9	6.7	4.2	3.9	2.3	1.6
250	27.1	5.8	4.1	4.0	2.5	1.8
200	23.6	5.4	4.3	4.5	3.3	2.1
100	20.0	6.1	3.5	4.3	3.3	2.5

TABLE 3.12

% RMS CHANGE FOR PERIOD
Mean period 950905 to 950924
Verification against analyses
rel humidity

T+	6	24	48	72	96	120
AREA 2						
950	38	2.6	1.7	0.6	1	-0.6
850	48.2	4	2.5	0.8	1.4	1.2
700	35.1	6.6	1.6	2	1.7	0.4
500	35.7	3.9	-0.6	0.8	0.4	-1
N HEM TO 30N						
950	88.1	3.1	1.1	0.7	0.6	0.3
850	98.1	5.1	2.5	1.8	0.8	0.8
700	78.2	6.7	1.9	2.4	0.4	0.5
500	82.2	4.7	0.1	1.7	0.8	0
TROPICS 30N-30S						
950	77.5	3.3	0.6	0.5	0.5	0.9
850	81.4	4.2	1.9	1.3	0.3	-0.1
700	80.4	4.3	1.7	0.8	1	0.5
500	89.5	7.6	2.3	2.1	1.3	0.6
S HEM FROM 30S						
950	92.8	4.9	4.9	11	3.5	-9.8
850	71	6.5	4.5	3.4	0	-1.8
700	110	17.6	3.9	2.8	1	0.4
500	85	10.5	3.4	0.8	0.4	1.6

% RMS CHANGE FOR PERIOD
Mean period 950905 to 950924
Verification against analyses
surfac pressure

T+	6	24	48	72	96	120
AREA 2						
	5.3	7.1	6	2.6	2.6	3.8
N HEM TO 30N						
	6.4	2.6	4	3.6	4.3	2.1
TROPICS 30N-30S						
	-1.8	-2	2	-0.7	0.7	2.1
S HEM FROM 30S						
	10.2	2	2.8	3.6	2.7	3.3

TABLE 3.13

TABLE 3.14

Parallel suite estimate of impact on NWP index
950905 to 950924

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
NH	PMSL	T+24	10	220	183.8	11.97	187.6	11.73	-0.24
NH	PMSL	T+48	8	350	280.5	9.98	291.8	9.6	-0.39
NH	PMSL	T+72	6	470	388.4	7.26	398.2	7.08	-0.18
NH	PMSL	T+96	4	570	490.6	4.65	506.2	4.5	-0.14
NH	PMSL	T+120	4	680	591	4.6	597.3	4.55	-0.05
NH	H500	T+24	6	15.9	14.5	6.57	15	6.37	-0.19
NH	H500	T+48	4	28.8	24.9	4.64	25.3	4.56	-0.08
NH	H500	T+72	2	42.8	36.3	2.36	37	2.32	-0.04
NH	W250	T+24	12	6	5.8	12.5	5.9	12.29	-0.21
Tropics	W850	T+24	5	3.3	2.5	6.63	2.5	6.55	-0.08
Tropics	W850	T+48	3	4.3	3.4	3.83	3.4	3.77	-0.06
Tropics	W850	T+72	2	5	4	2.49	4.1	2.46	-0.03
Tropics	W250	T+24	6	5.2	4.1	7.59	4.4	7.12	-0.47
SH	PMSL	T+24	5	290	299.7	4.84	309.5	4.68	-0.15
SH	PMSL	T+48	4	470	487.6	3.86	501	3.75	-0.1
SH	PMSL	T+72	3	620	645	2.88	663.6	2.8	-0.08
SH	PMSL	T+96	2	760	798.3	1.9	823	1.85	-0.06
SH	PMSL	T+120	2	870	953.4	1.83	985.9	1.76	-0.06
SH	H500	T+24	3	24.1	25.7	2.81	26.7	2.71	-0.11
SH	H500	T+48	2	42.4	43.4	1.96	44.7	1.9	-0.06
SH	H500	T+72	1	59.5	60	0.99	61.9	0.96	-0.03
SH	W250	T+24	6	6.3	6.2	6.09	6.6	5.7	-0.39

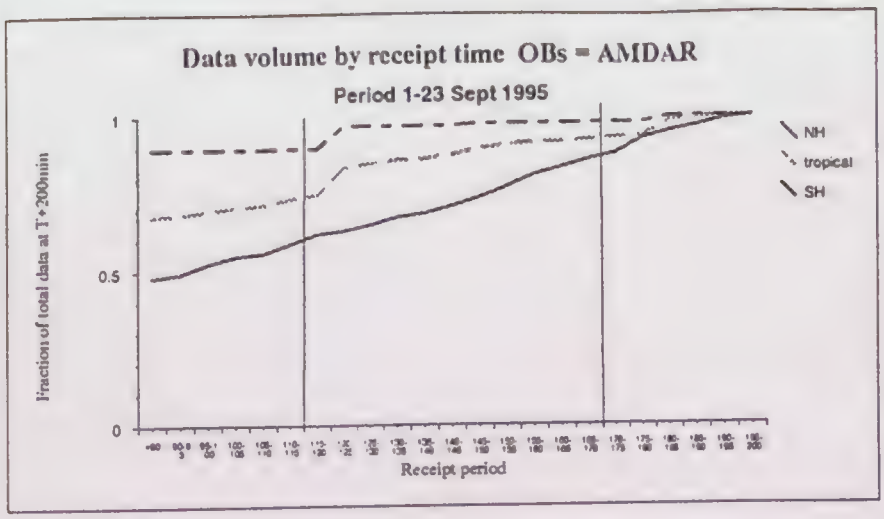
Total	weight:	100
Control	index:	112.21
Test	index:	109.01

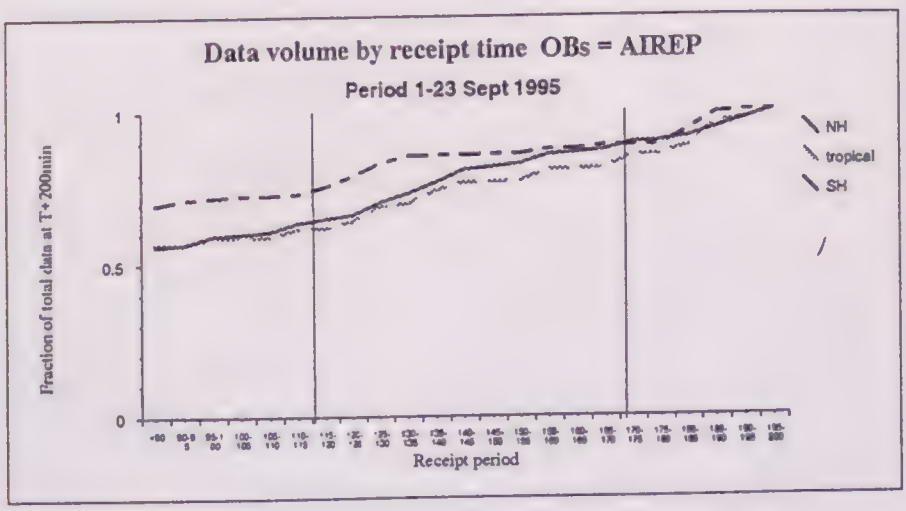
Notes:
(1) Area of verification. Limits of Tropics are at 20 degrees.
(2) Field of verification.
(3) VT of verification.
(4) Weight used in index, W_i.
(5) E_i for this field
(6) Operational RMS for this period.
(7) Operational contribution to index (W_i * E_i / RMS)
(8) P/suite RMS for this period.
(9) P/suite contribution to index (W_i * E_i / RMS)
(10) Change in contribution to index ((9)-(7))

TABLE A.1

GLOBAL MODEL 1-23 Sep 1995 Data Volumes by Receipt Time VT 00 UTC

	VT period(mins)	<VT+90	90-95	95-100	100-105	105-110	110-115	115-120	120-125	125-130	130-135	135-140	140-145	145-150	150-155	155-160	160-165	165-170	170-175	175-180	180-185	185-190	190-195	195-200
Ob Type	Hemisphere																							
AMDAR	North	40017	1185	1416	644	1046	678	558	818	555	261	630	659	657	538	736	291	154	696	515	505	465	173	311
	Tropical	13029	229	266	166	184	156	168	2242	448	124	75	137	104	210	300	22	2	62	214	2402	568	74	65
	South	18002	0	0	0	0	0	0	3643	579	0	0	0	0	0	222	0	0	0	0	3185	961	0	0
AIREP	North	14564	122	732	41	67	760	119	114	1198	470	591	722	279	172	628	325	148	589	123	226	1013	429	1035
	Tropical	10394	10	564	2	10	500	14	199	545	20	274	462	2	35	371	70	20	312	14	140	595	37	396
	South	1199	16	30	0	0	0	0	88	82	0	0	0	0	3	6	0	0	0	0	136	134	0	0
Auto Buoy	North	10530	26	252	0	0	0	0	0	2	1	21	21	35	20	96	8	22	1	17	1	0	1	0
	Tropical	1635	1	25	2	9	1	0	0	3	2	161	37	1	7	19	11	135	16	0	1	3	1	1
	South	2608	8	12	6	12	8	4	18	1	1	282	379	5	5	3	32	113	18	174	50	5	21	2
SHIP	North	6629	68	12	48	12	16	26	87	10	51	20	40	21	28	18	53	12	5	9	46	13	28	16
	Tropical	4250	48	14	50	25	37	47	232	13	22	23	15	24	29	24	24	16	15	16	107	27	15	15
	South	720	1	2	1	3	0	1	58	0	0	0	2	1	0	2	3	1	0	2	23	0	0	0
DRIFTER	North	5980	136	120	94	103	56	134	75	36	130	49	176	86	116	167	167	133	138	152	139	168	147	91
	Tropical	3299	73	83	87	52	43	54	61	22	53	18	89	4	18	53	32	51	118	55	83	82	63	35
	South	2641	36	87	100	49	73	136	16	22	44	13	55	7	12	35	14	48	130	40	46	65	76	23
OWS	North	225	0	1	0	0	0	0	0	20	2	7	15	0	0	1	1	0	0	1	0	1	0	0
	Tropical	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	South	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SYNOP	North	47678	101	370	37	28	93	56	50	48	36	66	65	41	63	91	26	29	25	62	30	22	27	33
	Tropical	25337	184	421	120	379	129	63	68	94	98	728	209	31	114	120	64	229	47	23	198	77	74	98
	South	6698	14	9	9	249	5	16	1	3	2	551	433	8	30	5	51	279	53	3	24	4	2	3
SATEM	North	3264	10	126	88	100	0	0	18	99	60	0	72	53	72	11	9	148	64	98	140	0	0	74
	Tropical	5038	32	95	114	109	0	0	7	75	105	16	79	29	141	16	22	125	73	87	112	0	0	92
	South	3613	44	70	99	78	0	0	0	41	76	14	46	11	94	0	19	67	32	55	58	0	0	60
SATOB	North	3511	156	89	115	45	85	0	46	121	0	119	431	701	11	58	345	0	64	0	65	0	50	63
	Tropical	18719	1384	828	940	339	576	471	431	2369	491	604	3658	3951	238	995	1653	694	618	0	862	0	1308	601
	South	4548	177	164	119	49	42	84	0	174	154	0	819	1697	0	212	262	83	170	0	69	0	68	0
TEMP A	North	4935	818	713	459	398	527	115	109	70	239	92	143	130	101	51	39	33	22	23	9	19	9	11
	Tropical	1479	593	97	24	44	19	25	114	73	238	47	228	61	72	65	57	106	70	50	59	63	51	35
	South	258	395	16	9	6	9	9	14	3	9	4	8	12	22	5	7	7	1	4	3	5	1	1
TEMP B	North	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tropical	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	South	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHIP TEMP A	North	96	23	0	0	3	6	4	1	2	3	1	0	1	0	2	3	1	4	2	0	0	0	2
	Tropical	43	8	2	1	0	5	1	1	0	1	0	2	0	6	26	2	2	1	0	0	0	0	0
	South	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHIP TEMP B	North	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tropical	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	South	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PILOT A	North	3648	41	22	6	9	6	21	50	5	62	145	436	0	3	33	1	2	0	4	1	0	0	0
	Tropical	1976	90	66	41	46	41	62	62	37	18	19	30	13	18	9	16	12	11	8	8	12	8	6
	South	788	10	0	19	0	0	0	1	2	2	0	2	0	0	2	0	0	1	0	0	3	0	0
PILOT B	North	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tropical	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	South	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0


Data volume by receipt time OBs = AMDAR
Period 1-23 Sept 1995
Fraction of total data at T+200min
1
0.5
0
NH
tropical
SH
Receipt period


Data volume by receipt time OBs = AIREP
Period 1-23 Sept 1995
Fraction of total data at T+200min
1
0.5
0
NH
tropical
SH
Receipt period

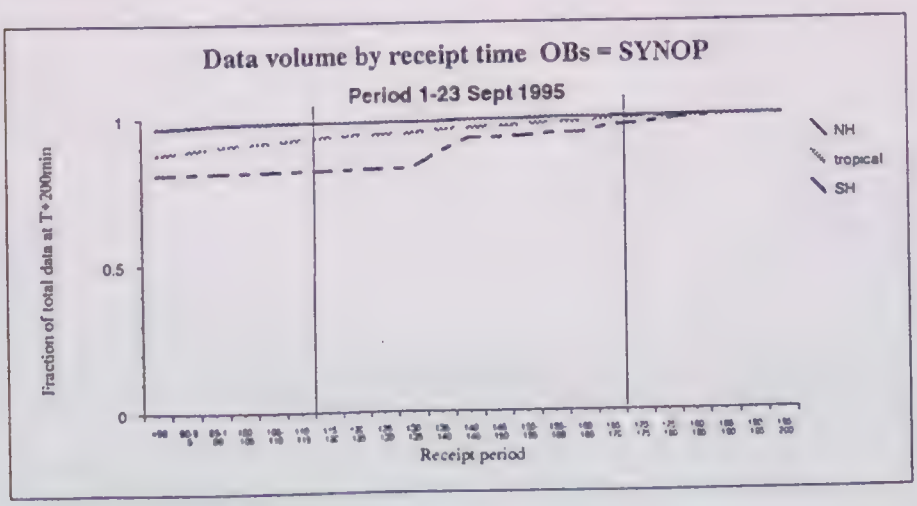
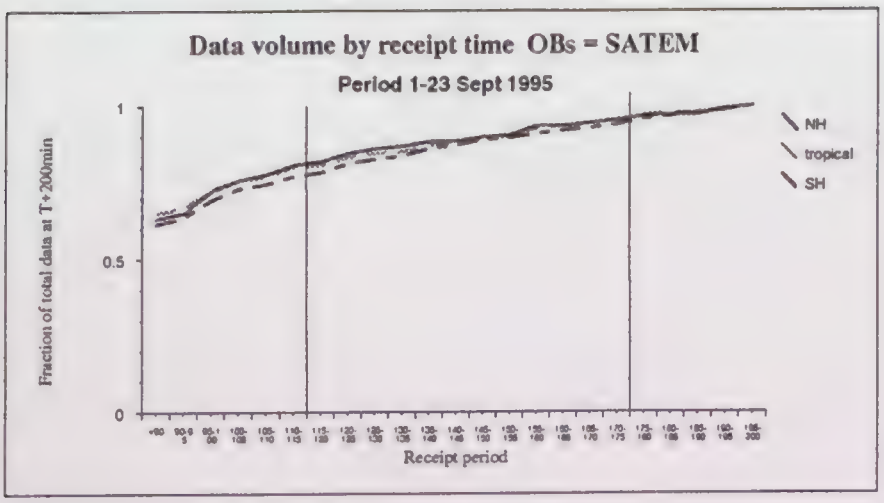
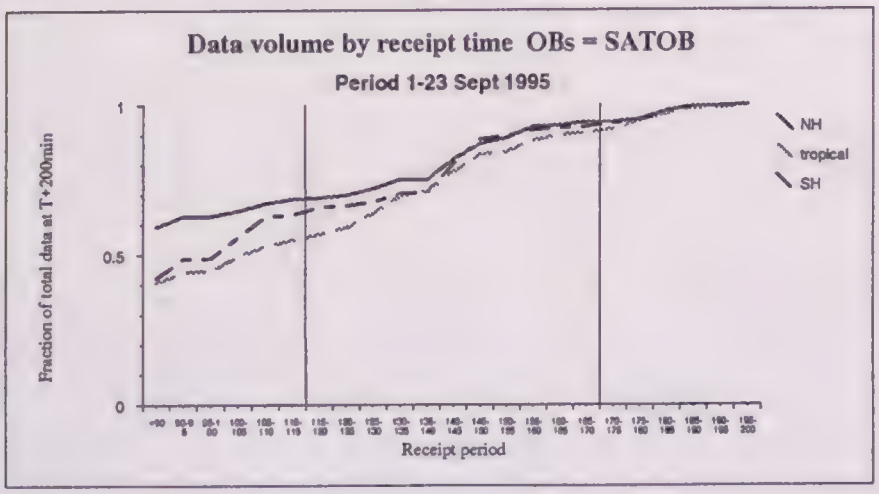

Data volume by receipt time OBs = SYNOP
Period 1-23 Sept 1995
Fraction of total data at T+200min
1
0.5
0
NH
tropical
SH
Receipt period

FIGURE 2.1


Data volume by receipt time OBs = SATEM
Period 1-23 Sept 1995
Fraction of total data at T+200min
1
0.5
0
NH
tropical
SH
Receipt period


Data volume by receipt time OBs = SATOB
Period 1-23 Sept 1995
Fraction of total data at T+200min
1
0.5
0
NH
tropical
SH
Receipt period

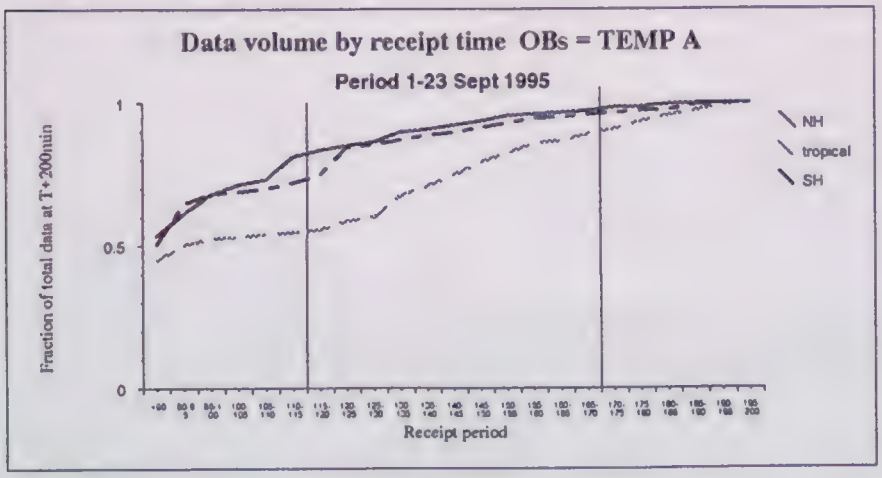
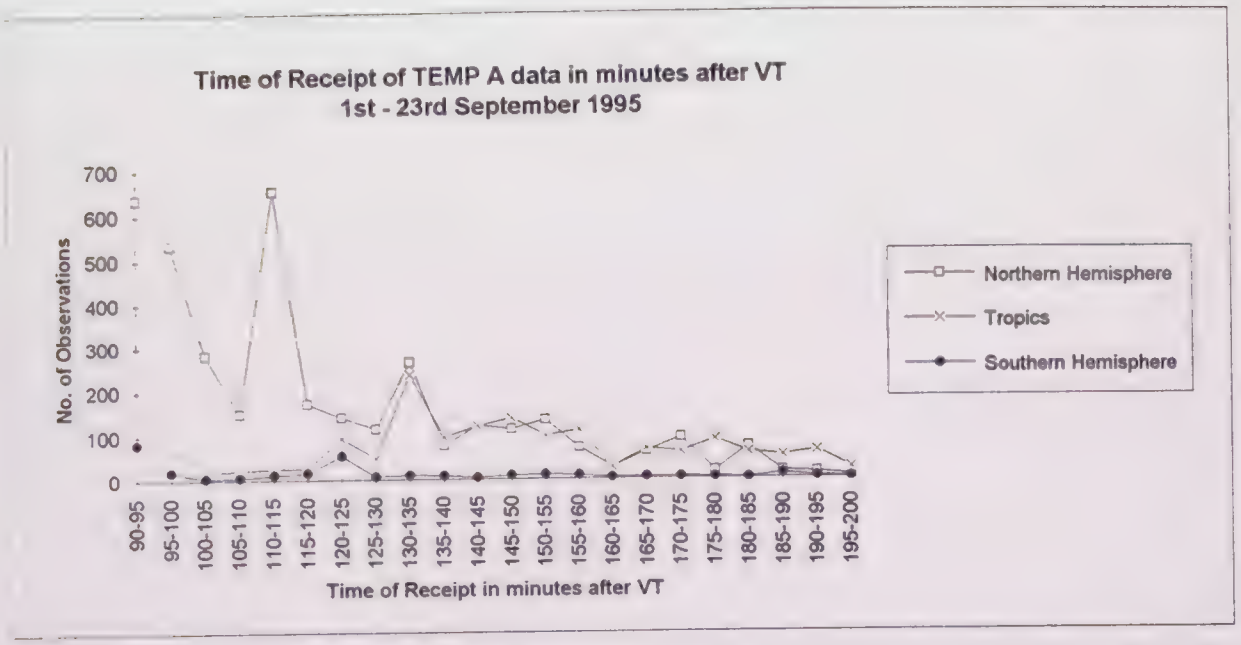

Data volume by receipt time OBs = TEMP A
Period 1-23 Sept 1995
Fraction of total data at T+200min
1
0.5
0
NH
tropical
SH
Receipt period

FIGURE 2.2


Time of Receipt of TEMP A data in minutes after VT
1st - 23rd September 1995
No. of Observations
700
600
500
400
300
200
100
0
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

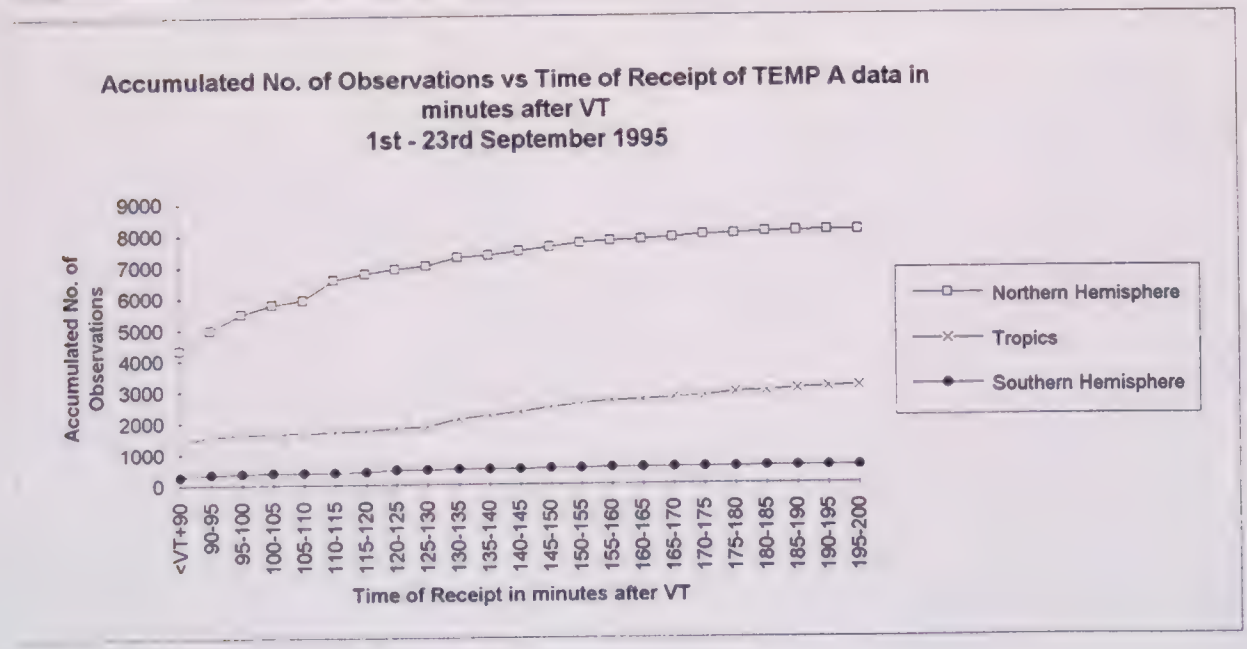
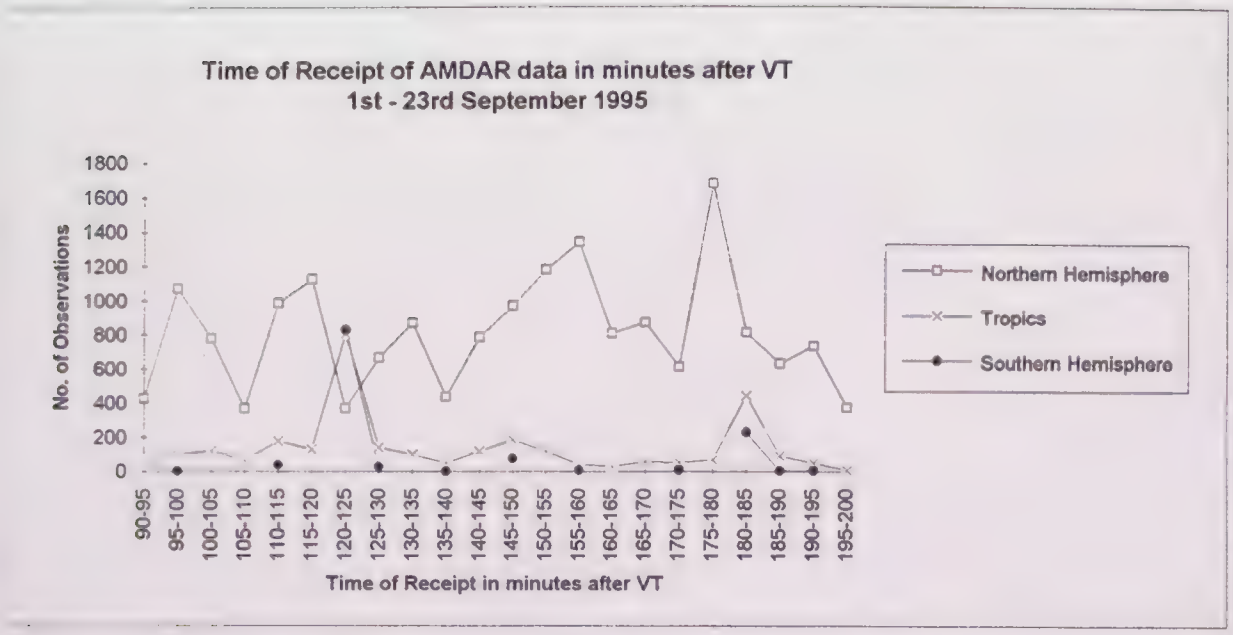

Accumulated No. of Observations vs Time of Receipt of TEMP A data in minutes after VT
1st - 23rd September 1995
Accumulated No. of Observations
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
<VT+90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

FIGURE 2.3


Time of Receipt of AMDAR data in minutes after VT
1st - 23rd September 1995
No. of Observations
1800
1600
1400
1200
1000
800
600
400
200
0
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

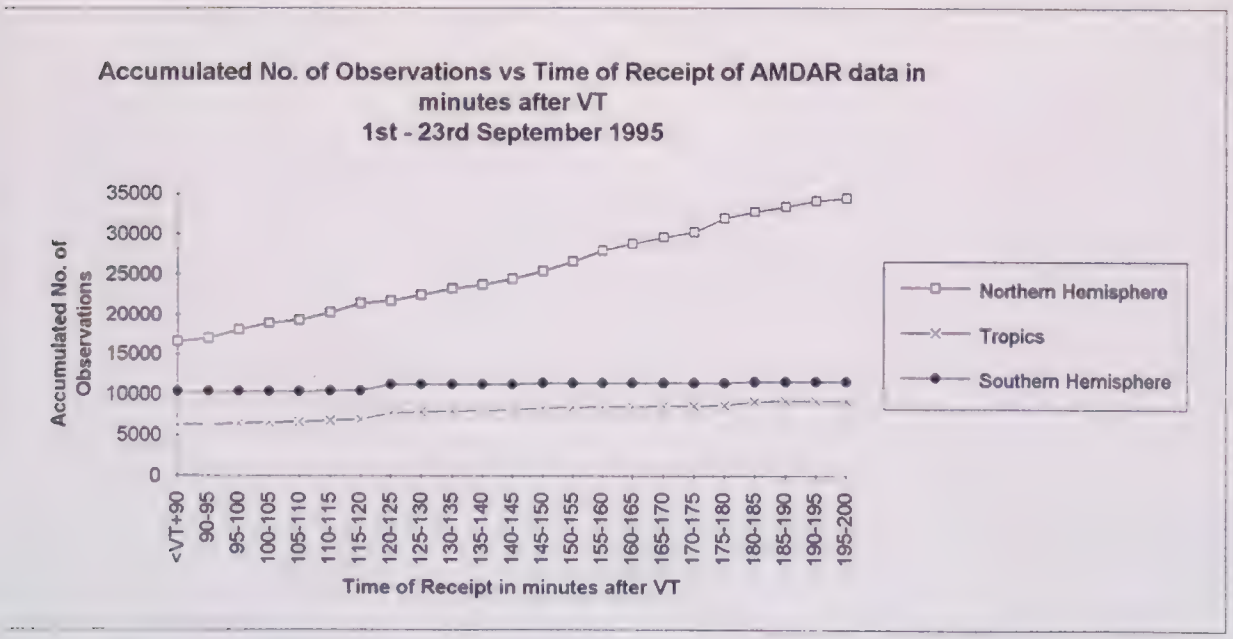
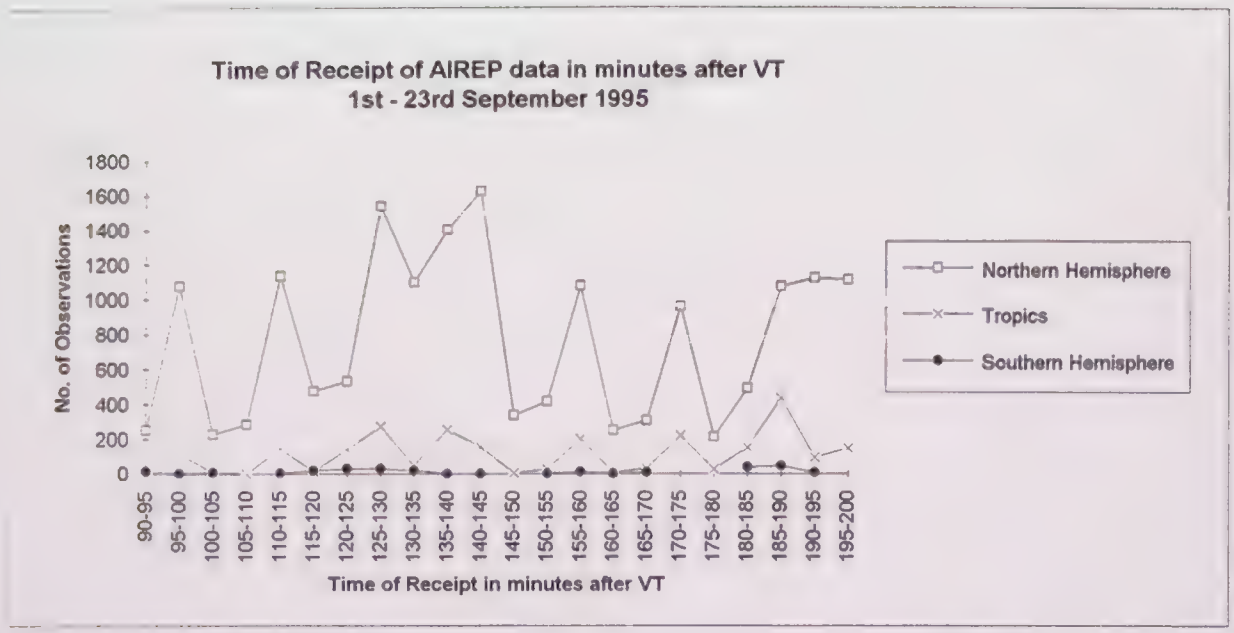

Accumulated No. of Observations vs Time of Receipt of AMDAR data in minutes after VT
1st - 23rd September 1995
Accumulated No. of Observations
35000
30000
25000
20000
15000
10000
5000
0
<VT+90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

FIGURE 2.4


Time of Receipt of AIREP data in minutes after VT
1st - 23rd September 1995
No. of Observations
1800
1600
1400
1200
1000
800
600
400
200
0
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

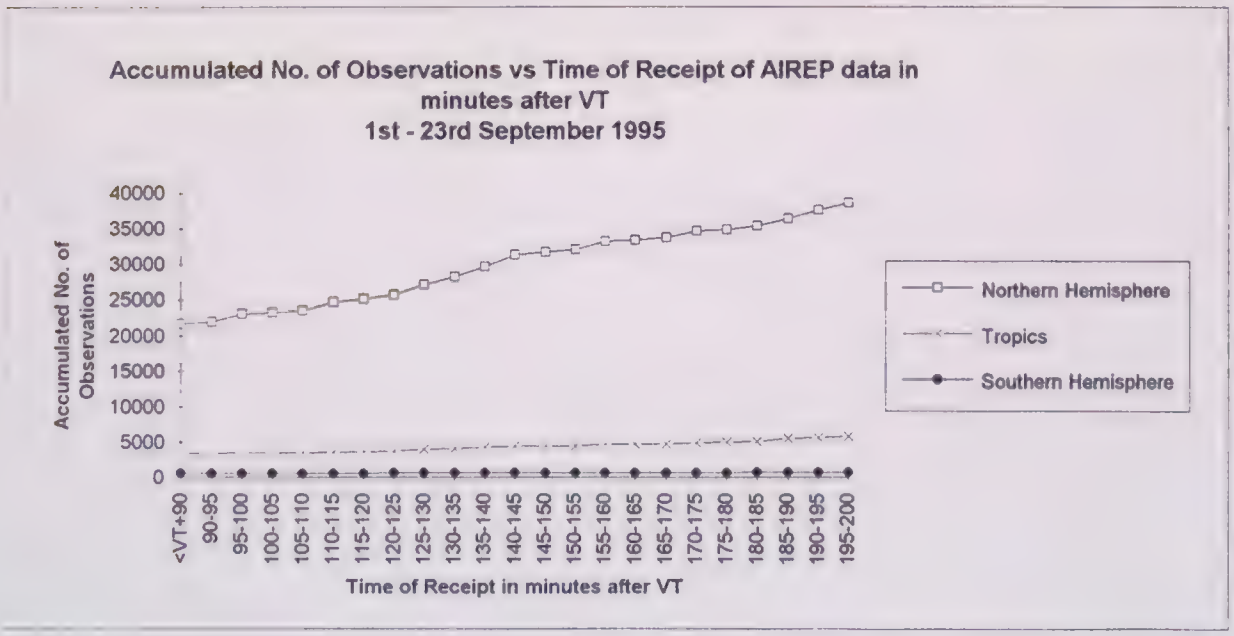
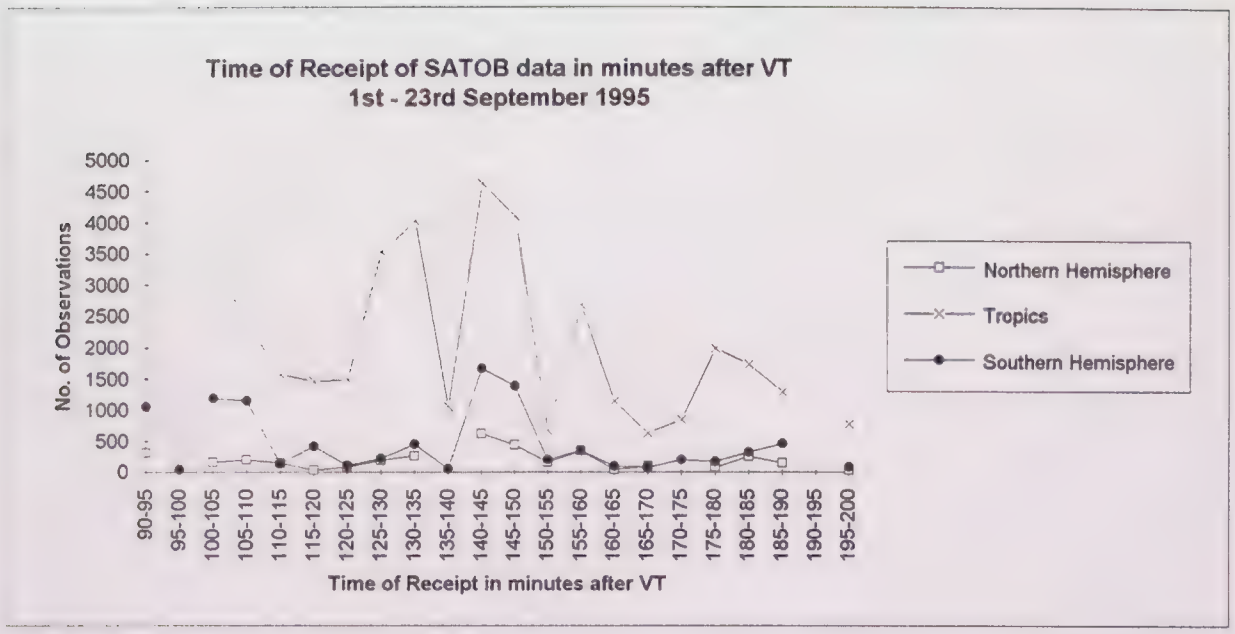

Accumulated No. of Observations vs Time of Receipt of AIREP data in minutes after VT
1st - 23rd September 1995
Accumulated No. of Observations
40000
35000
30000
25000
20000
15000
10000
5000
0
<VT+90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

FIGURE 2.5


Time of Receipt of SATOB data in minutes after VT
1st - 23rd September 1995
No. of Observations
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

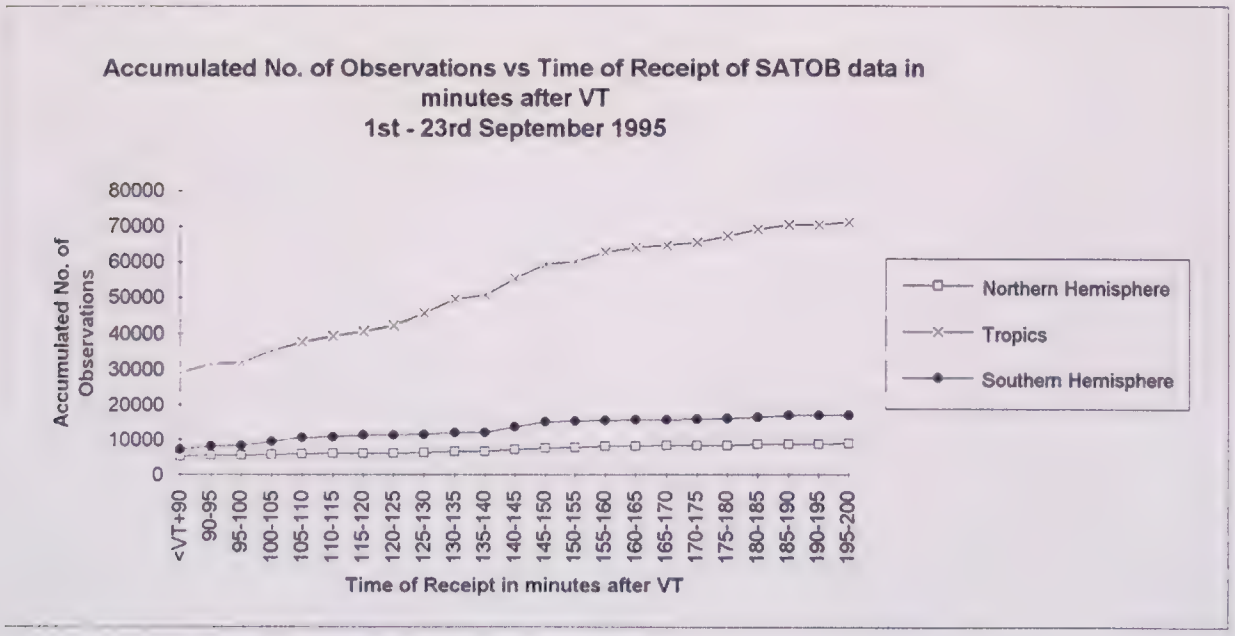

Accumulated No. of Observations vs Time of Receipt of SATOB data in minutes after VT
1st - 23rd September 1995
Accumulated No. of Observations
80000
70000
60000
50000
40000
30000
20000
10000
0
<VT+90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

FIGURE 2.6

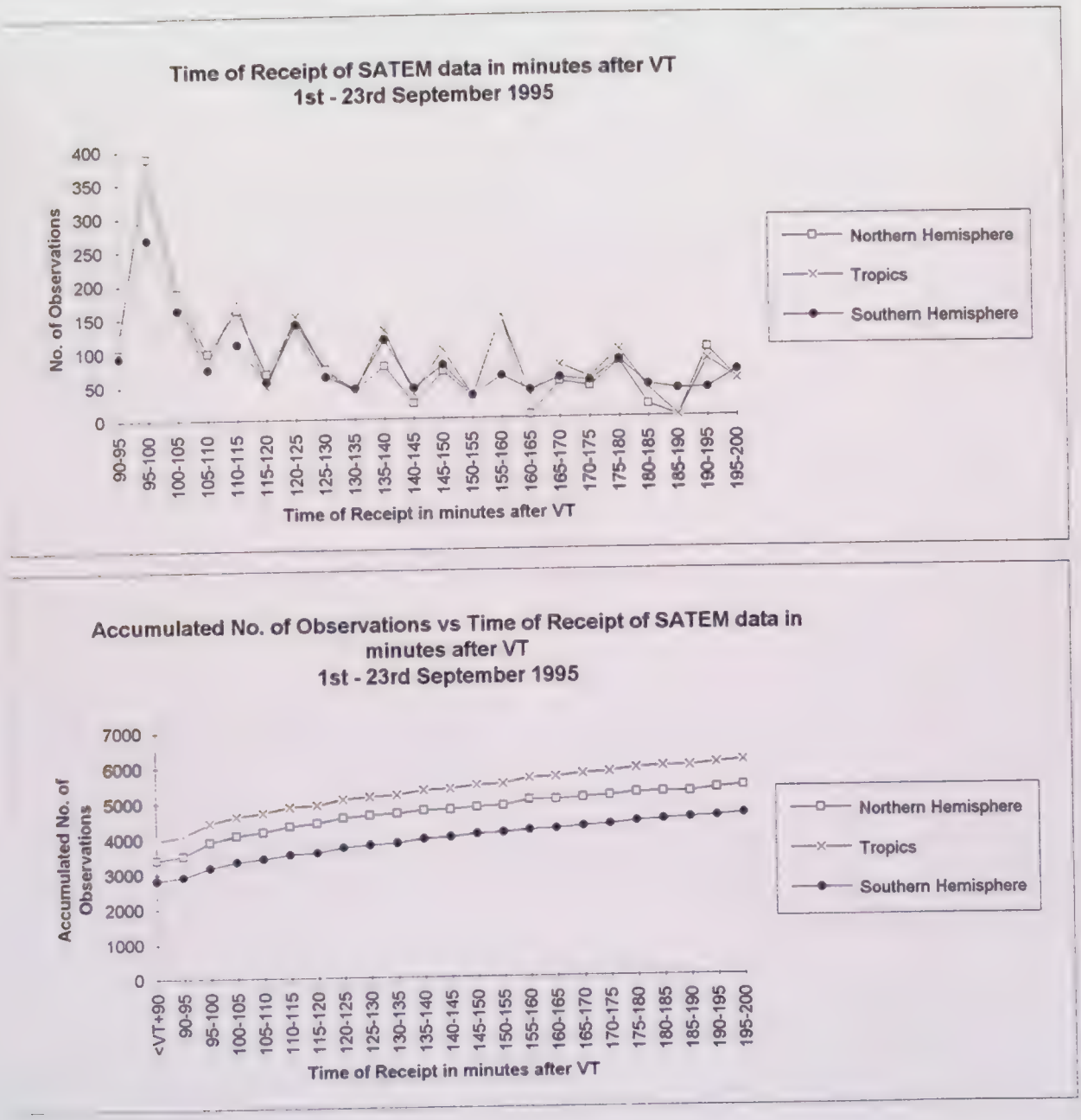
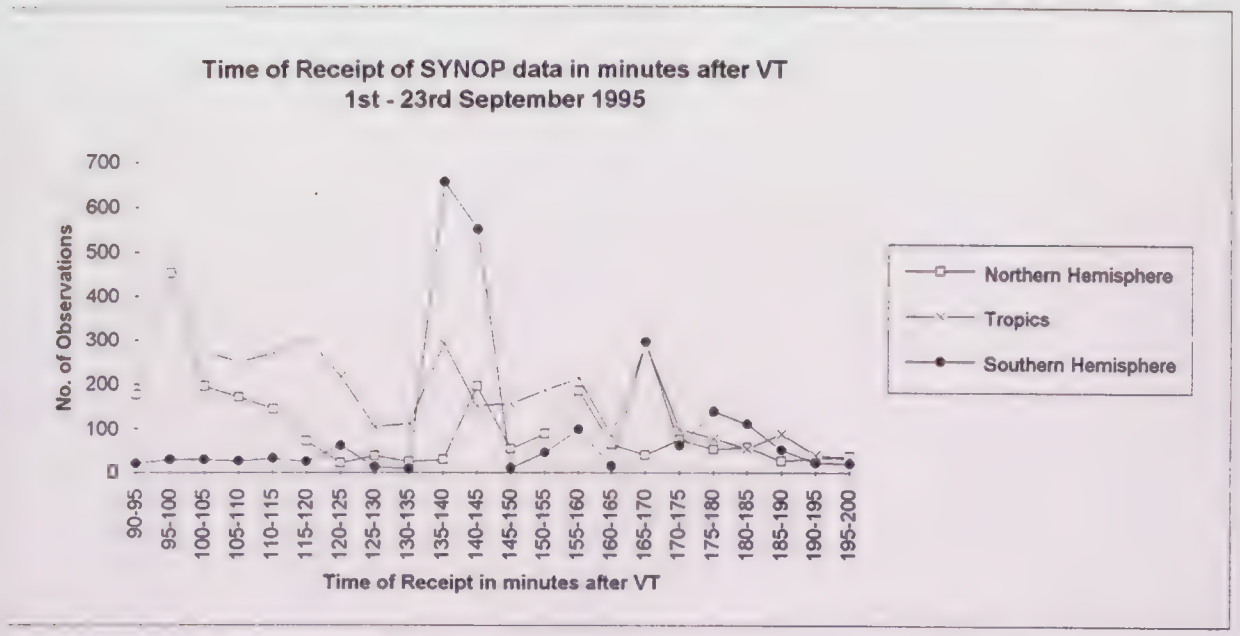

Time of Receipt of SATEM data in minutes after VT
1st - 23rd September 1995
No. of Observations
400
350
300
250
200
150
100
50
0
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere
Accumulated No. of Observations vs Time of Receipt of SATEM data in minutes after VT
1st - 23rd September 1995
Accumulated No. of Observations
7000
6000
5000
4000
3000
2000
1000
0
<VT+90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

FIGURE 2.7


Time of Receipt of SYNOP data in minutes after VT
1st - 23rd September 1995
No. of Observations
700
600
500
400
300
200
100
0
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

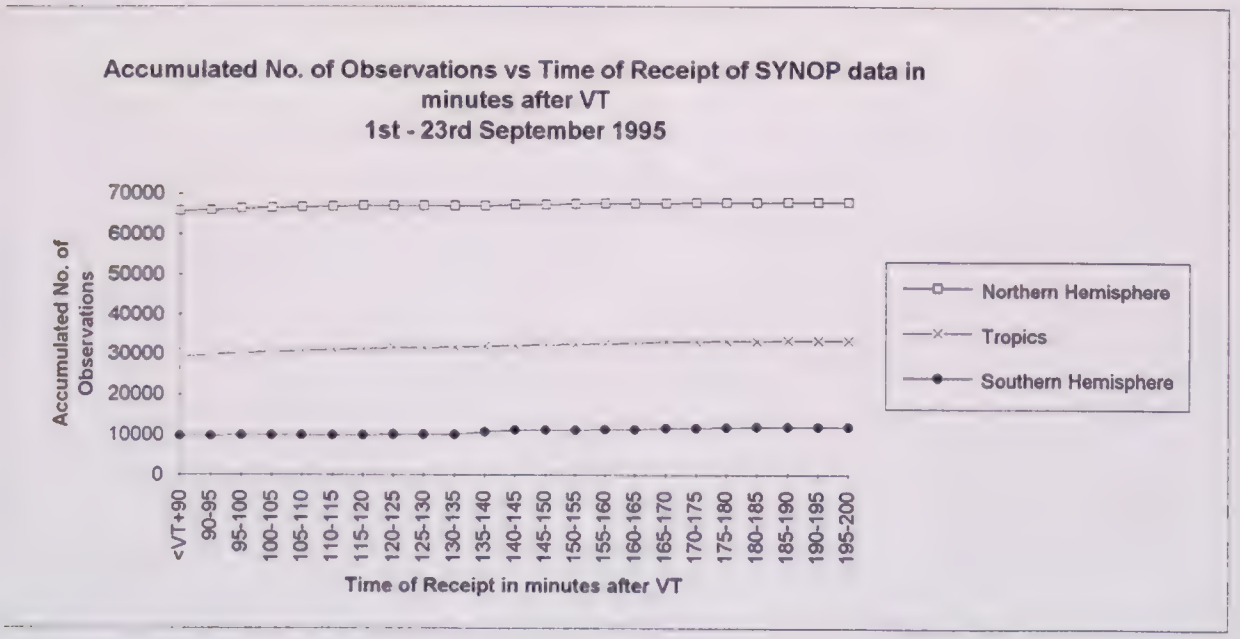
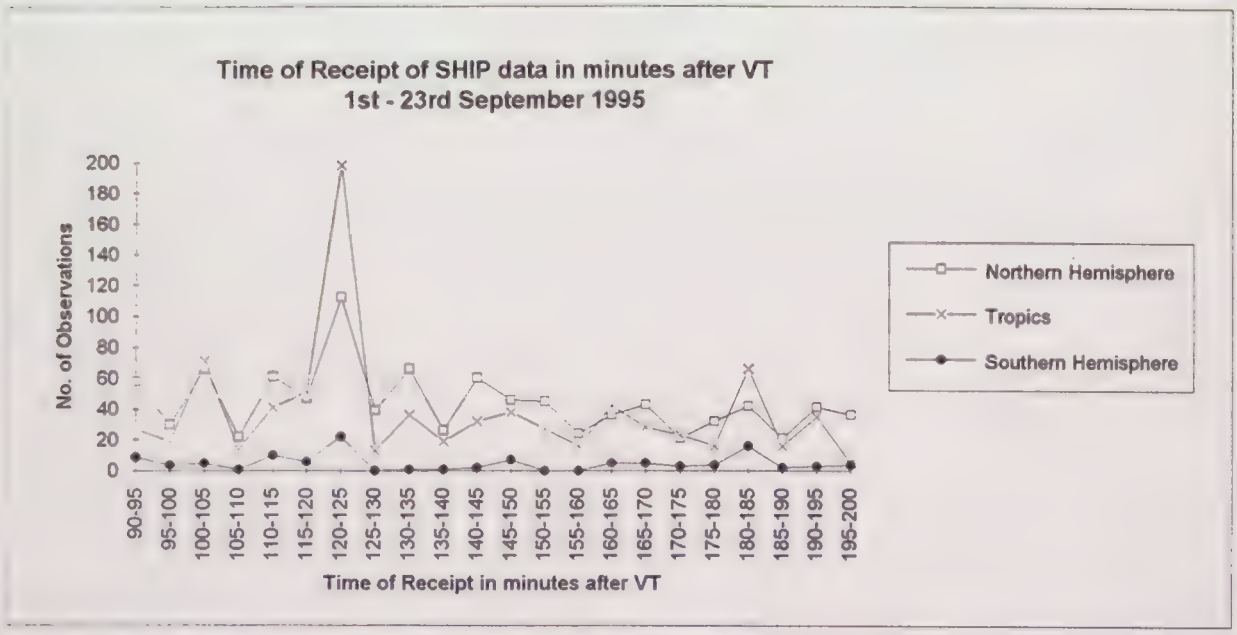

Accumulated No. of Observations vs Time of Receipt of SYNOP data in minutes after VT
1st - 23rd September 1995
Accumulated No. of Observations
70000
60000
50000
40000
30000
20000
10000
0
<VT+90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

FIGURE 2.8


Time of Receipt of SHIP data in minutes after VT
1st - 23rd September 1995
No. of Observations
200
180
160
140
120
100
80
60
40
20
0
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

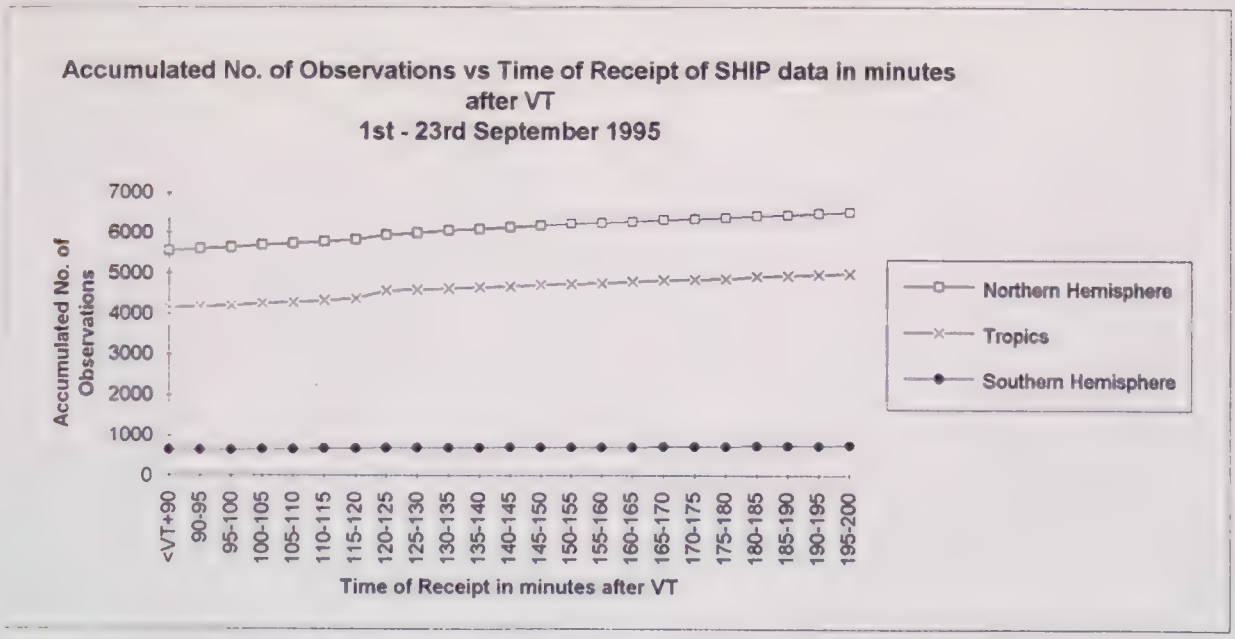
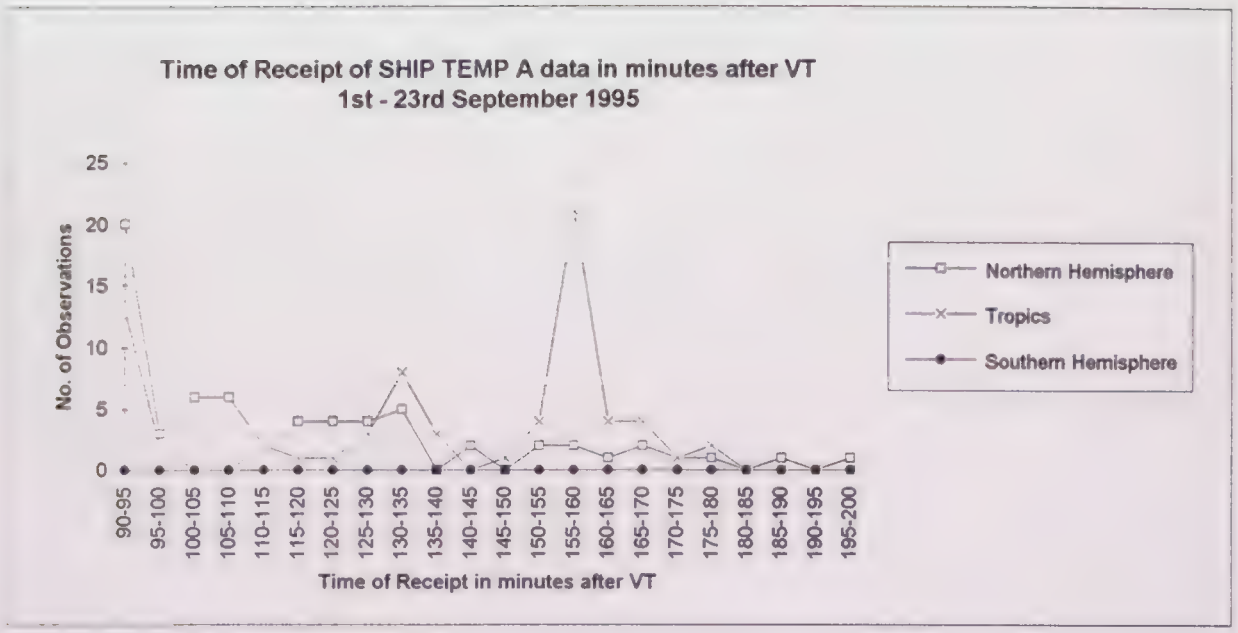

Accumulated No. of Observations vs Time of Receipt of SHIP data in minutes after VT
1st - 23rd September 1995
Accumulated No. of Observations
7000
6000
5000
4000
3000
2000
1000
0
<VT+90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

FIGURE 2.9


Time of Receipt of SHIP TEMP A data in minutes after VT
1st - 23rd September 1995
No. of Observations
25
20
15
10
5
0
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

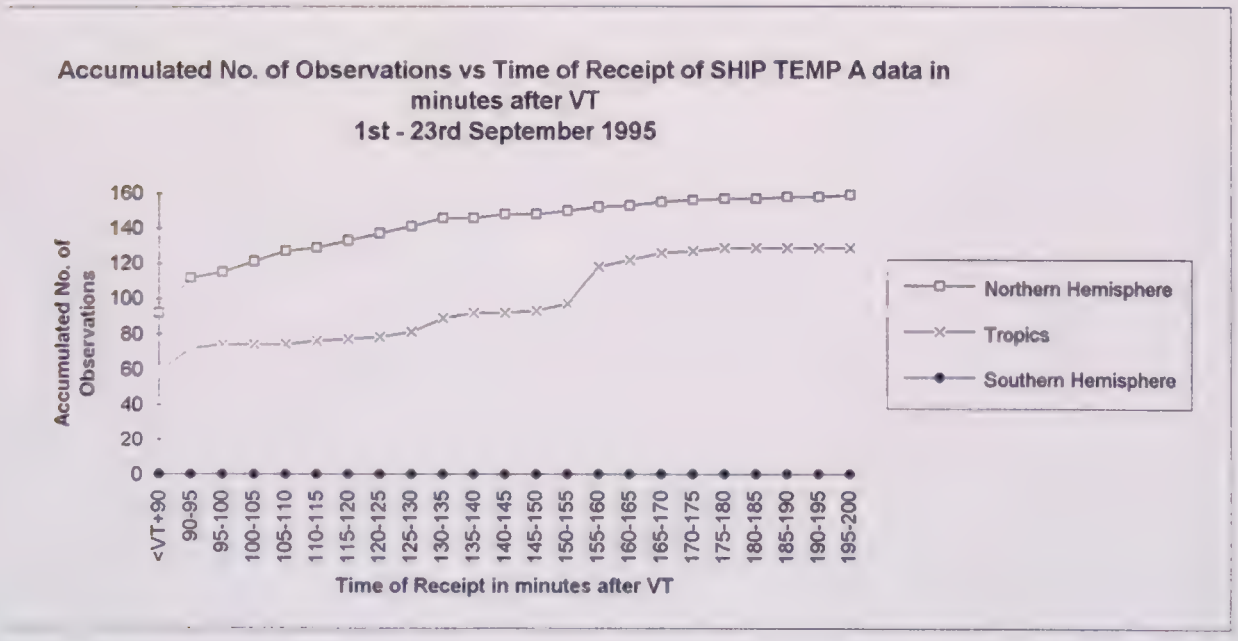

Accumulated No. of Observations vs Time of Receipt of SHIP TEMP A data in minutes after VT
1st - 23rd September 1995
Accumulated No. of Observations
160
140
120
100
80
60
40
20
0
<VT+90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

FIGURE 2.10

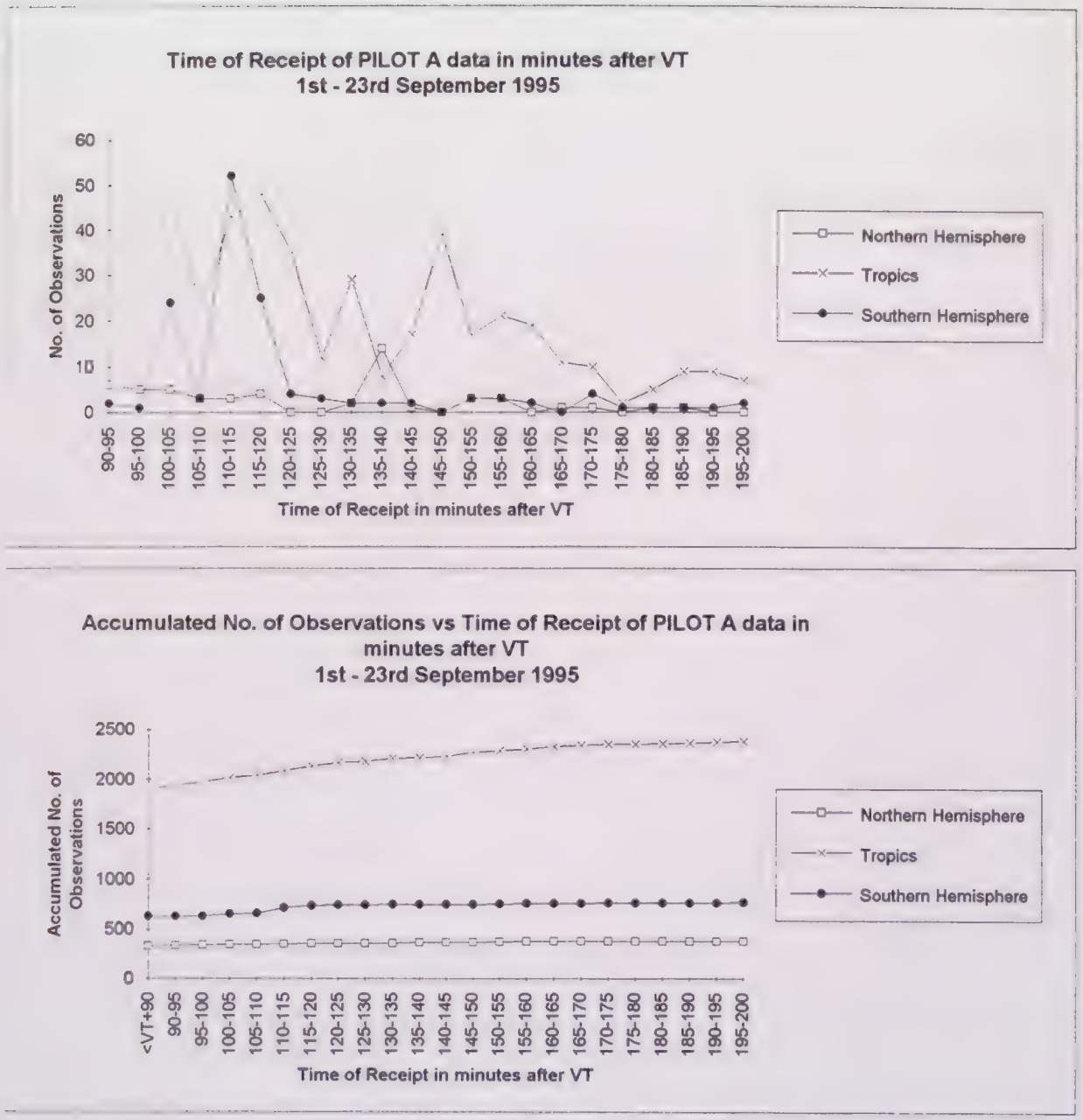

Time of Receipt of PILOT A data in minutes after VT
1st - 23rd September 1995
No. of Observations
60
50
40
30
20
10
0
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere
Accumulated No. of Observations vs Time of Receipt of PILOT A data in minutes after VT
1st - 23rd September 1995
Accumulated No. of Observations
2500
2000
1500
1000
500
0
<VT+90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

FIGURE 2.11

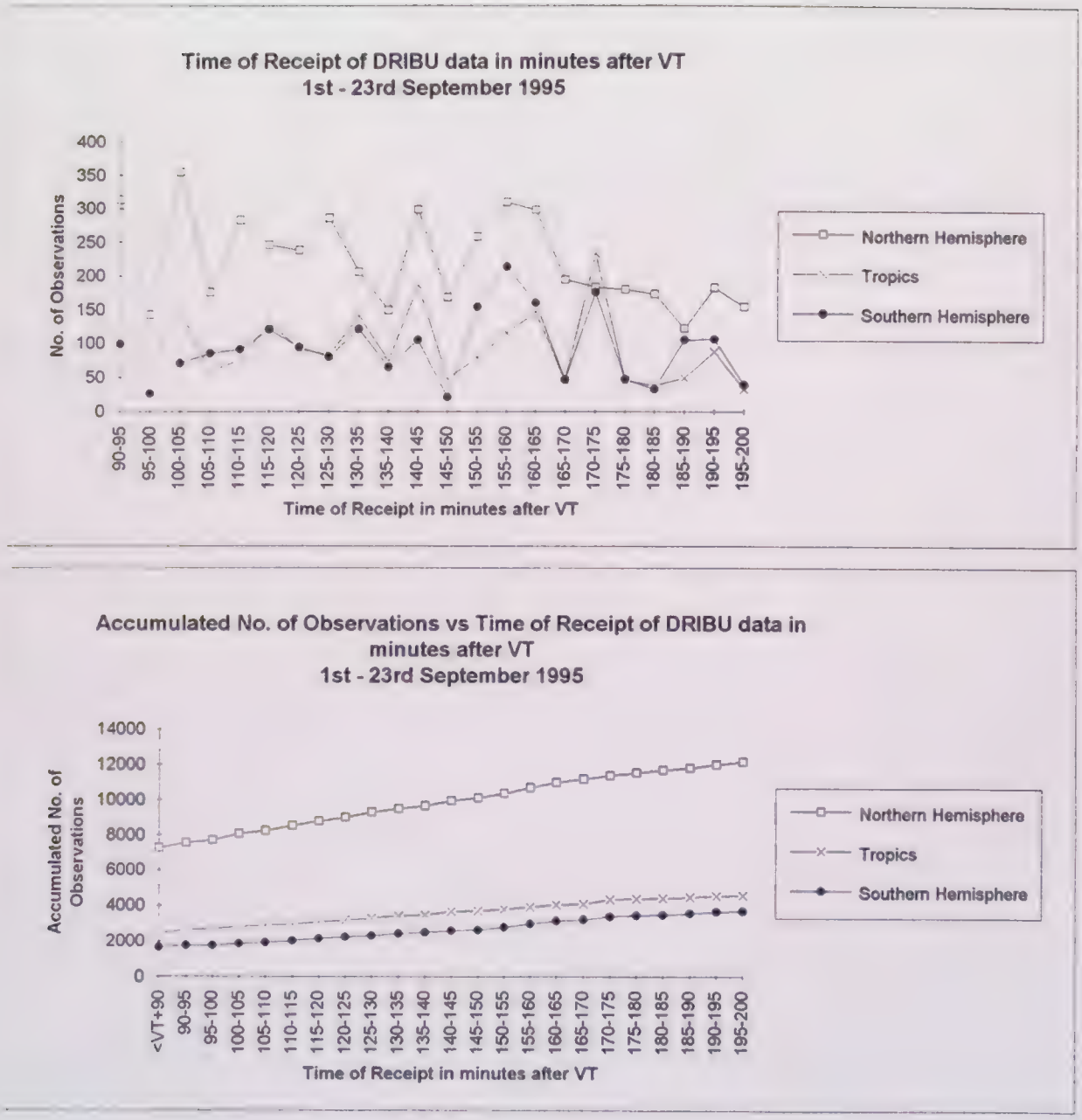

Time of Receipt of DRIBU data in minutes after VT
1st - 23rd September 1995
No. of Observations
400
350
300
250
200
150
100
50
0
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere
Accumulated No. of Observations vs Time of Receipt of DRIBU data in minutes after VT
1st - 23rd September 1995
Accumulated No. of Observations
14000
12000
10000
8000
6000
4000
2000
0
<VT+90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

FIGURE 2.12

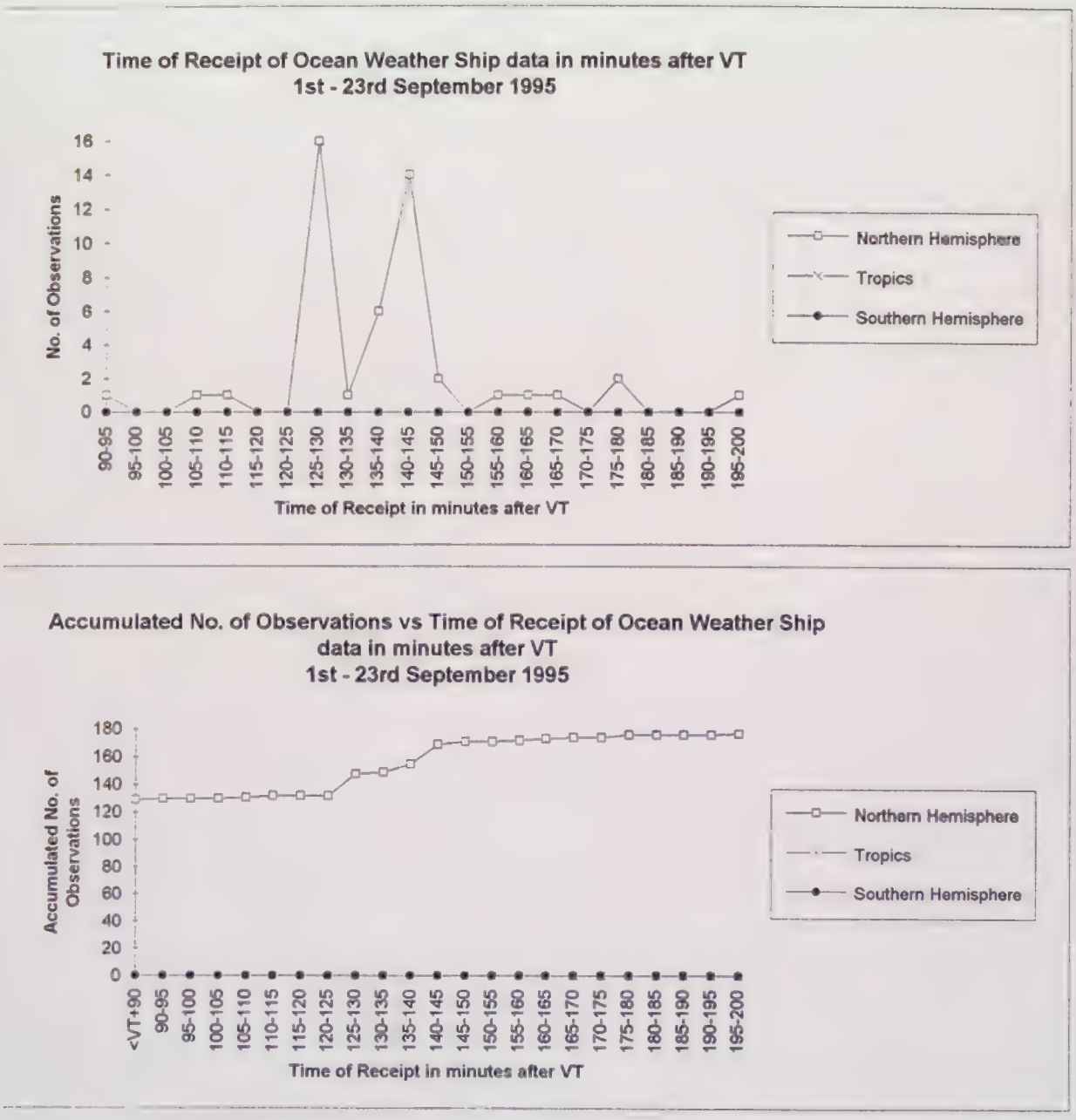

Time of Receipt of Ocean Weather Ship data in minutes after VT
1st - 23rd September 1995
No. of Observations
16
14
12
10
8
6
4
2
0
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere
Accumulated No. of Observations vs Time of Receipt of Ocean Weather Ship data in minutes after VT
1st - 23rd September 1995
Accumulated No. of Observations
180
160
140
120
100
80
60
40
20
0
<VT+90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

FIGURE 2.13

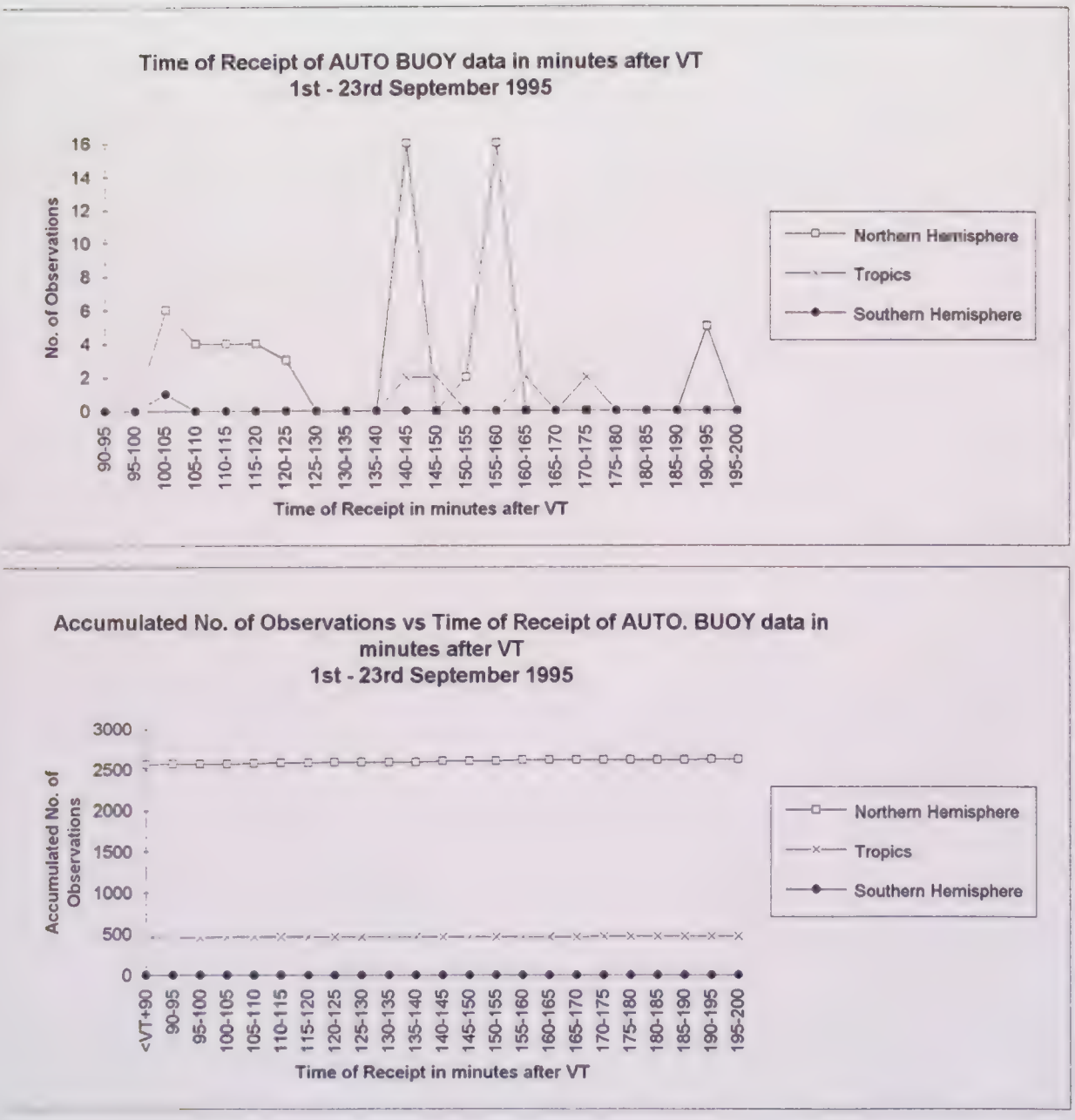
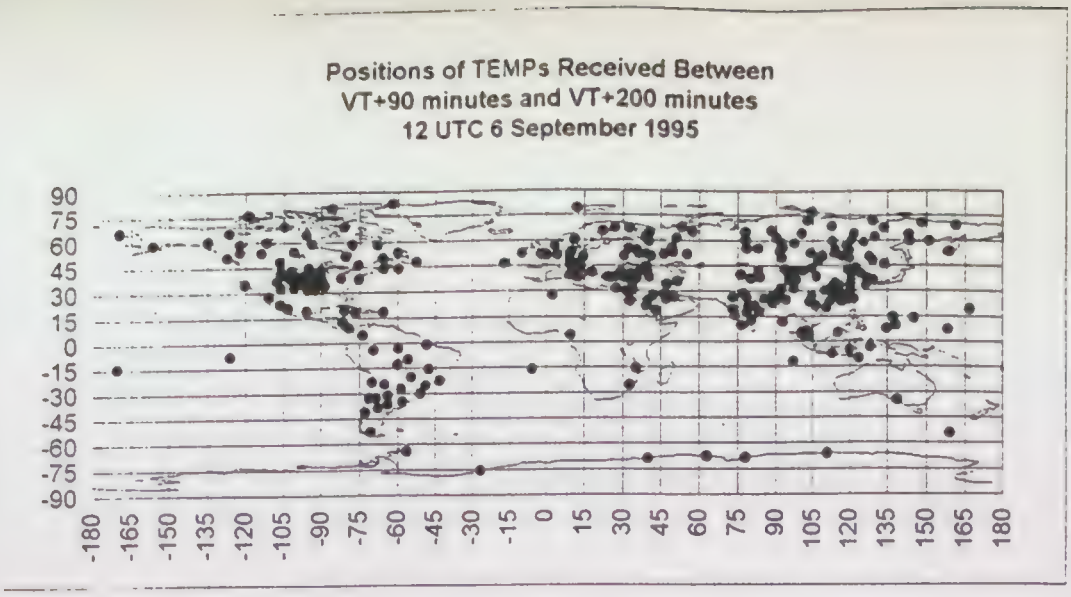
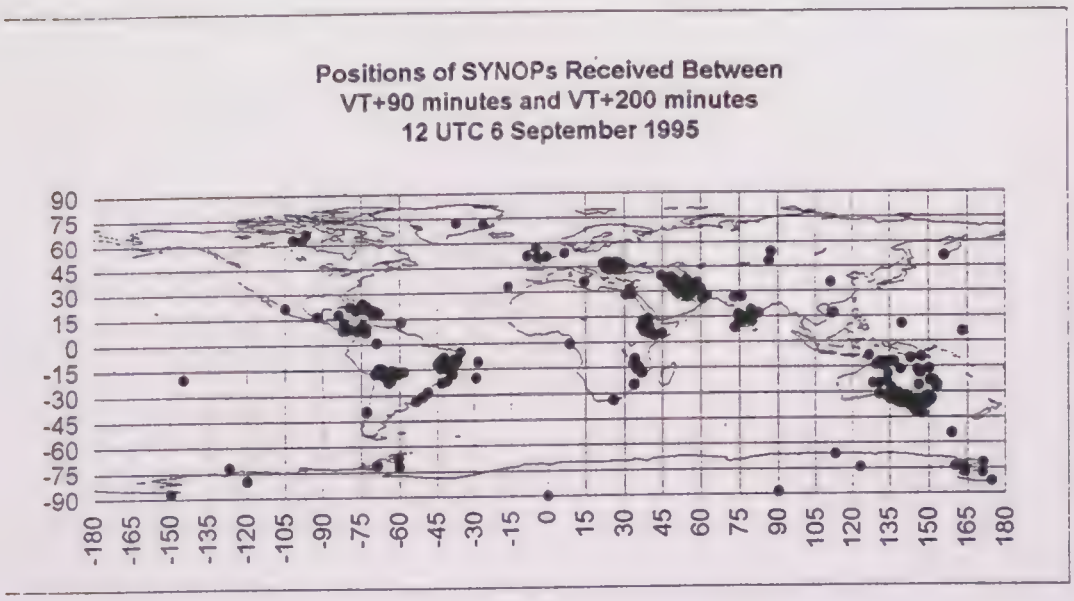

Time of Receipt of AUTO BUOY data in minutes after VT
1st - 23rd September 1995
No. of Observations
0
2
4
6
8
10
12
14
16
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere
Accumulated No. of Observations vs Time of Receipt of AUTO. BUOY data in minutes after VT
1st - 23rd September 1995
Accumulated No. of Observations
0
500
1000
1500
2000
2500
3000
<VT+90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

FIGURE 2.14


Positions of TEMPs Received Between
VT+90 minutes and VT+200 minutes
12 UTC 6 September 1995
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180


Positions of SYNOPs Received Between
VT+90 minutes and VT+200 minutes
12 UTC 6 September 1995
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180

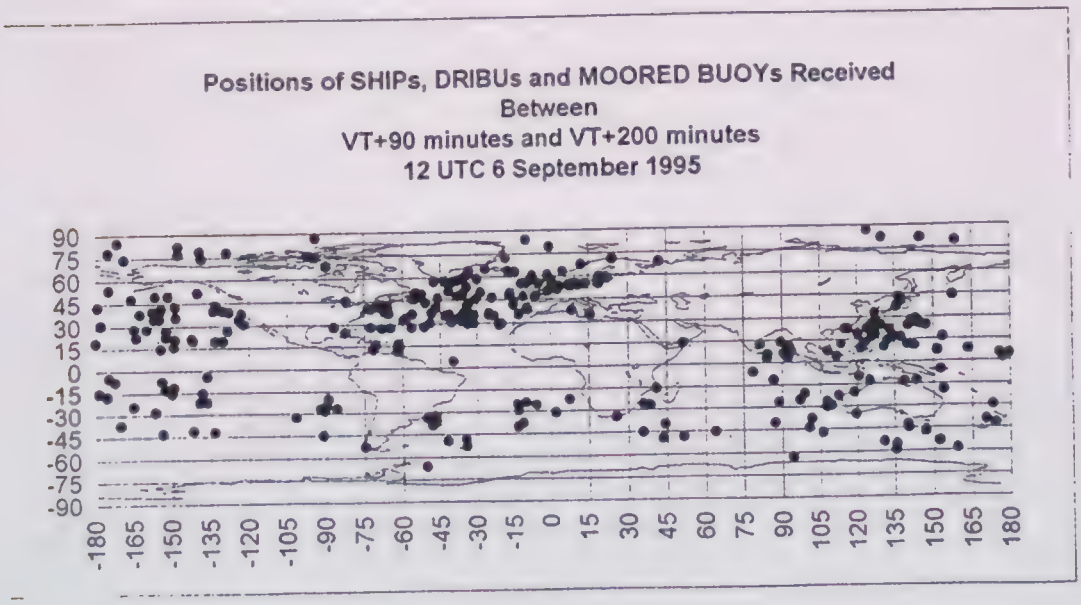
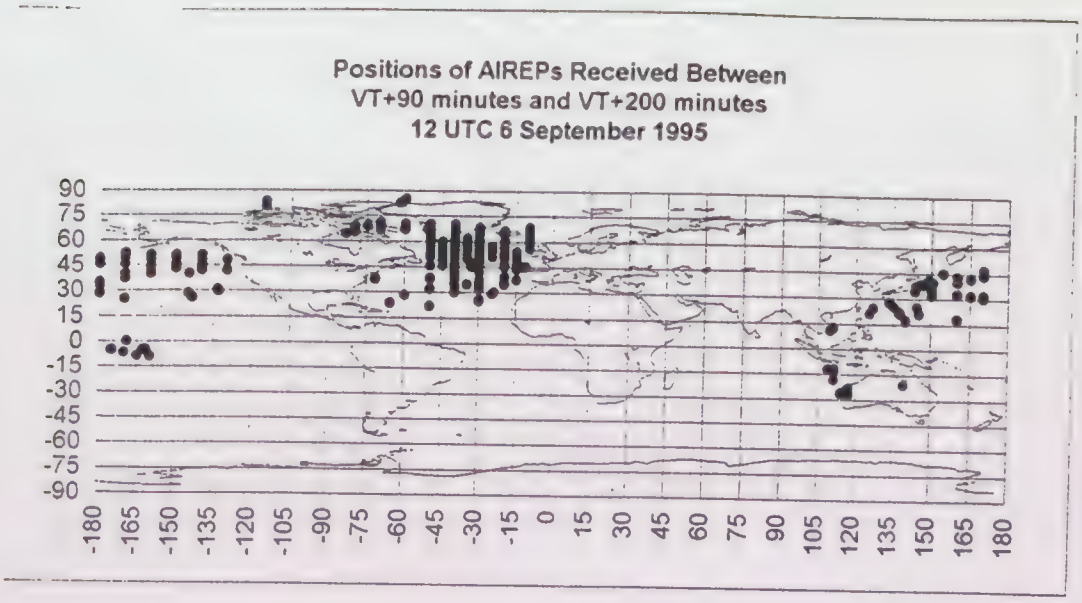

Positions of SHIPs, DRIBUs and MOORED BUOYs Received
Between
VT+90 minutes and VT+200 minutes
12 UTC 6 September 1995
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180

FIGURE 2.15


Positions of AIREPs Received Between
VT+90 minutes and VT+200 minutes
12 UTC 6 September 1995
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180

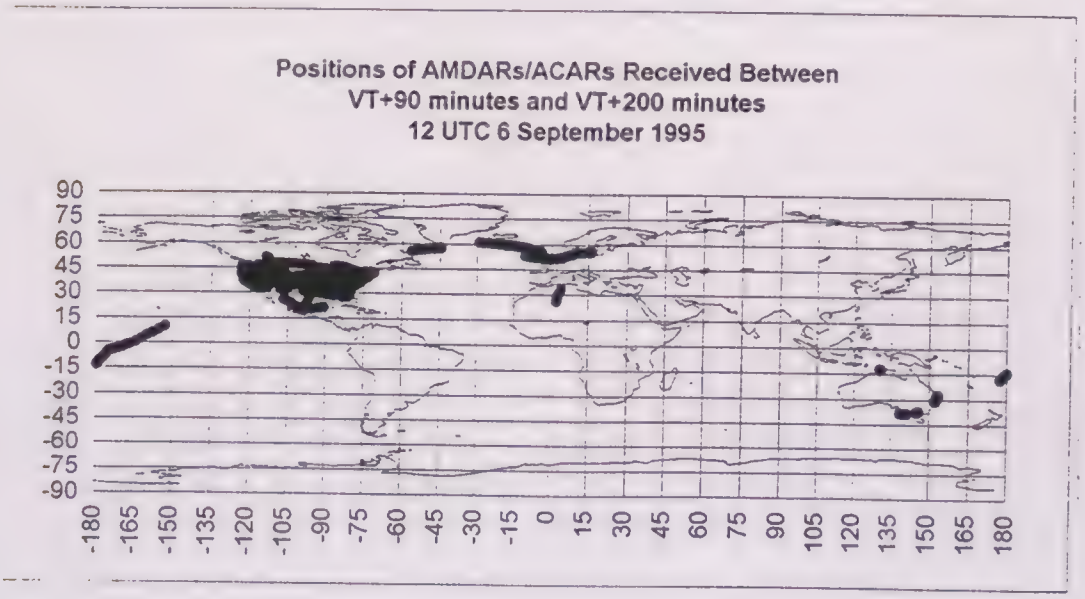

Positions of AMDARs/ACARs Received Between
VT+90 minutes and VT+200 minutes
12 UTC 6 September 1995
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180

FIGURE 2.16

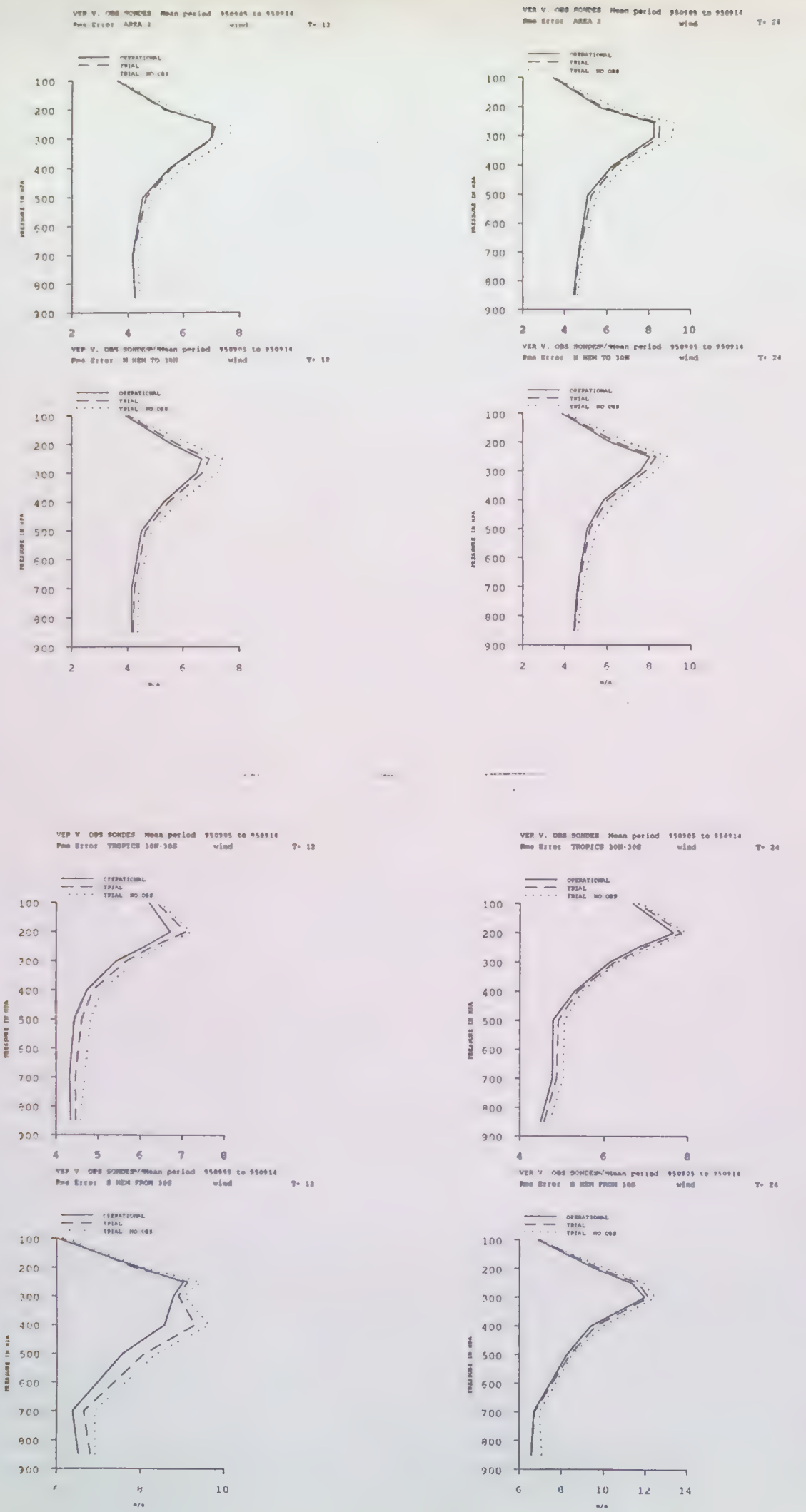

OPERATIONAL
TRIAL
TRIAL NO OBS
PRESSURE IN HPA
100
200
300
400
500
600
700
800
900
2
4
6
8
10
m/s

FIGURE 3.1

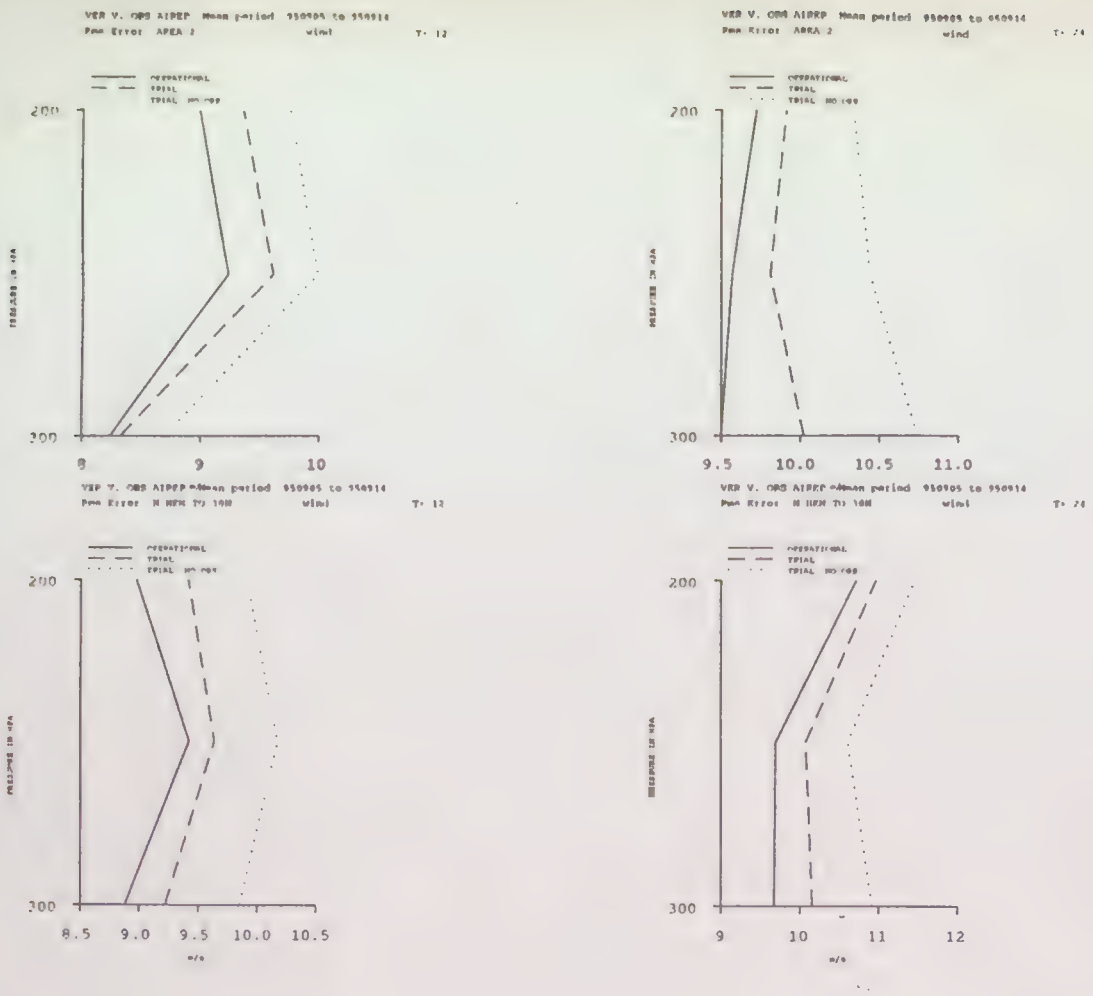


FIGURE 3.2

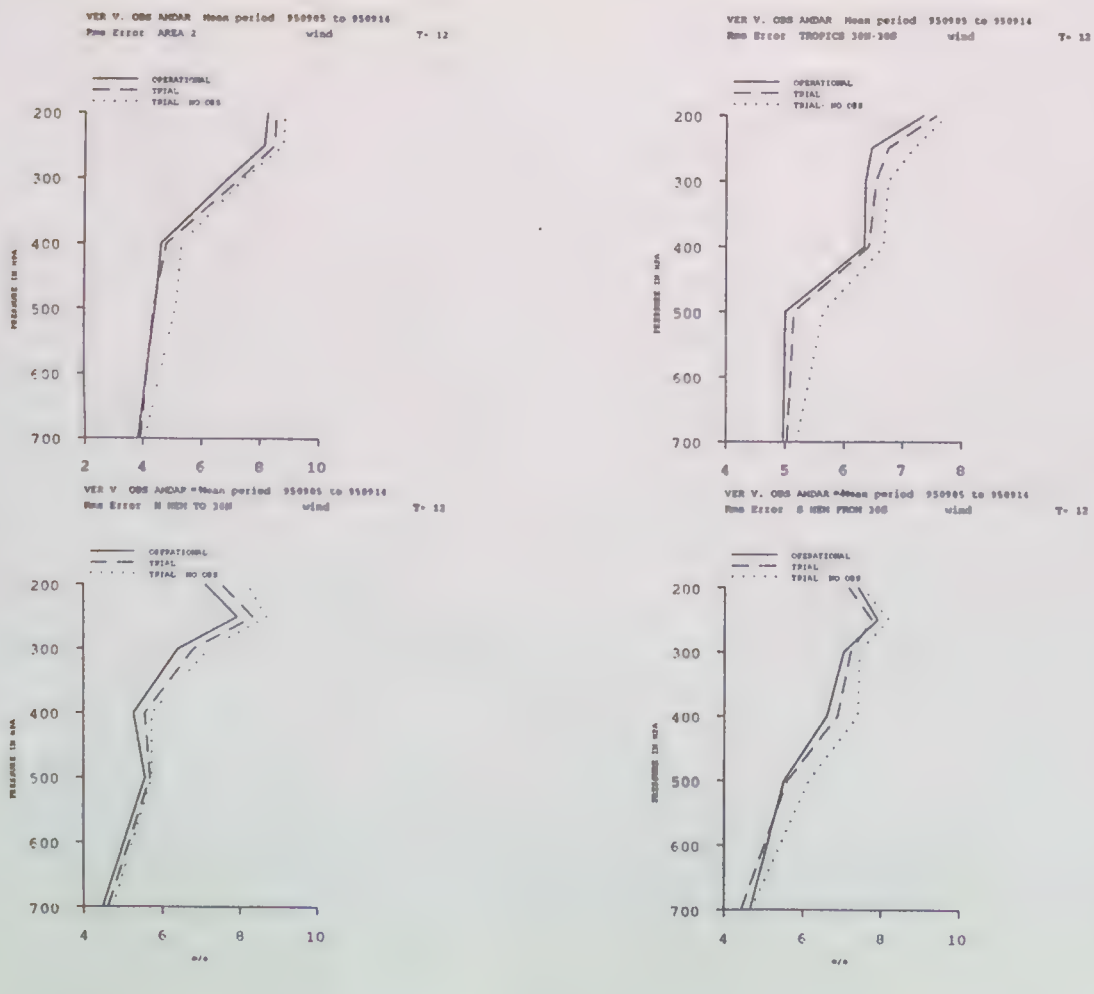


FIGURE 3.3

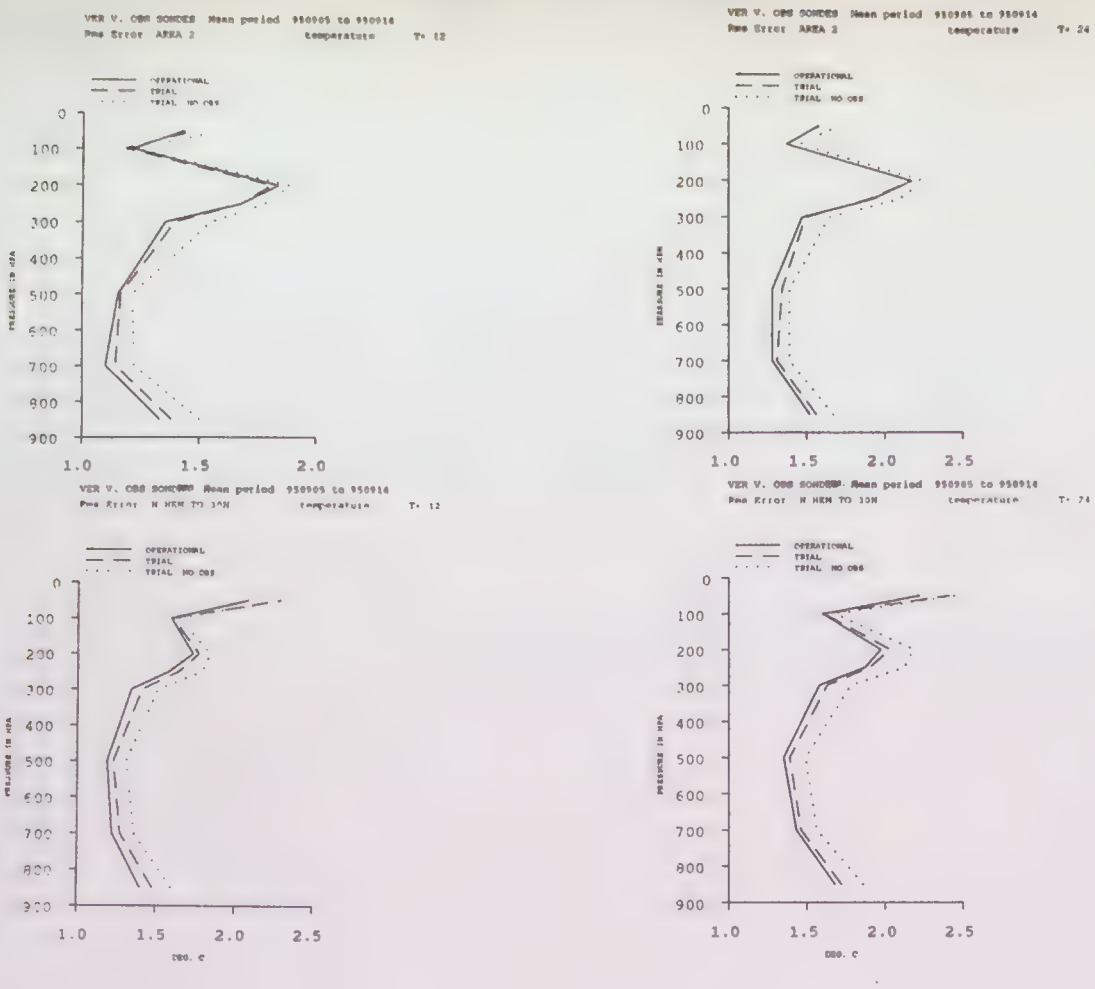


FIGURE 3.4

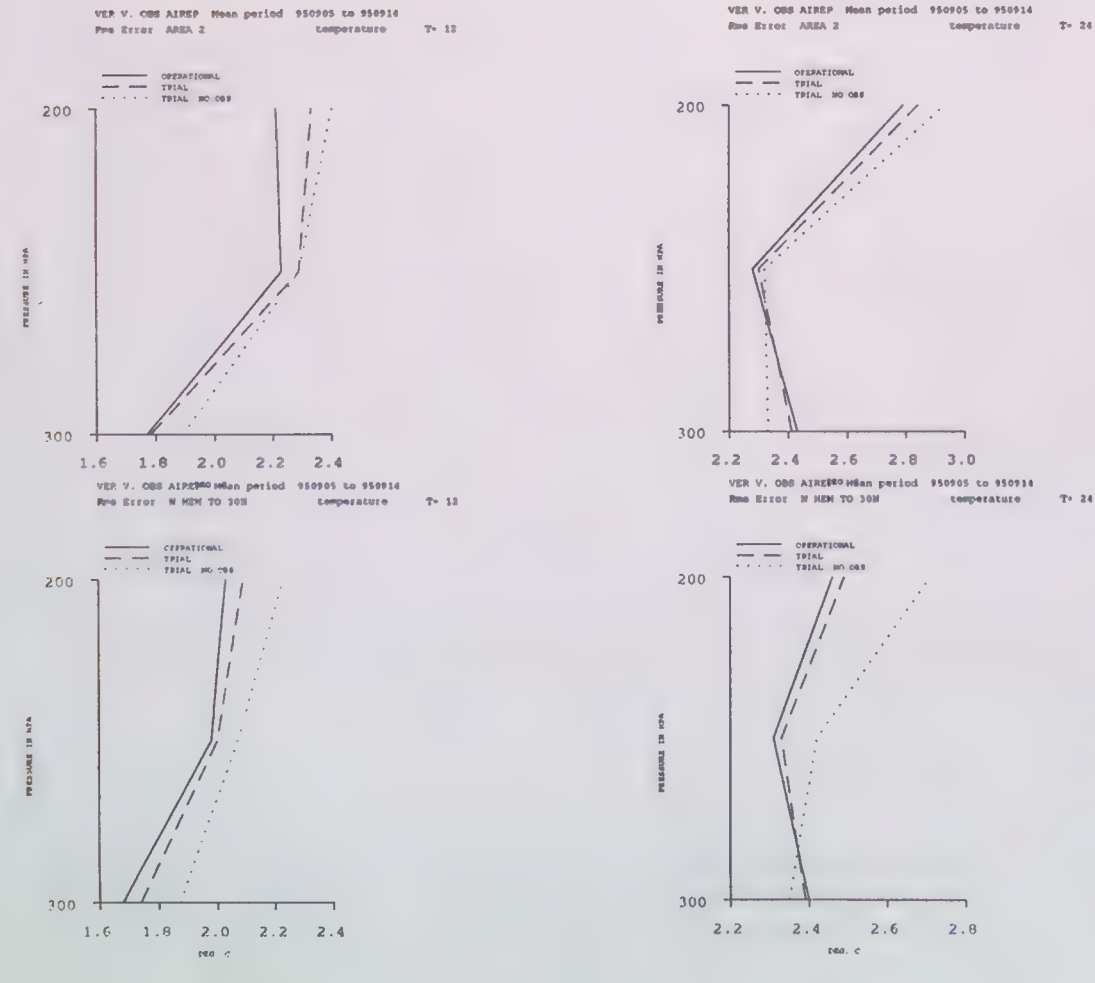


FIGURE 3.5

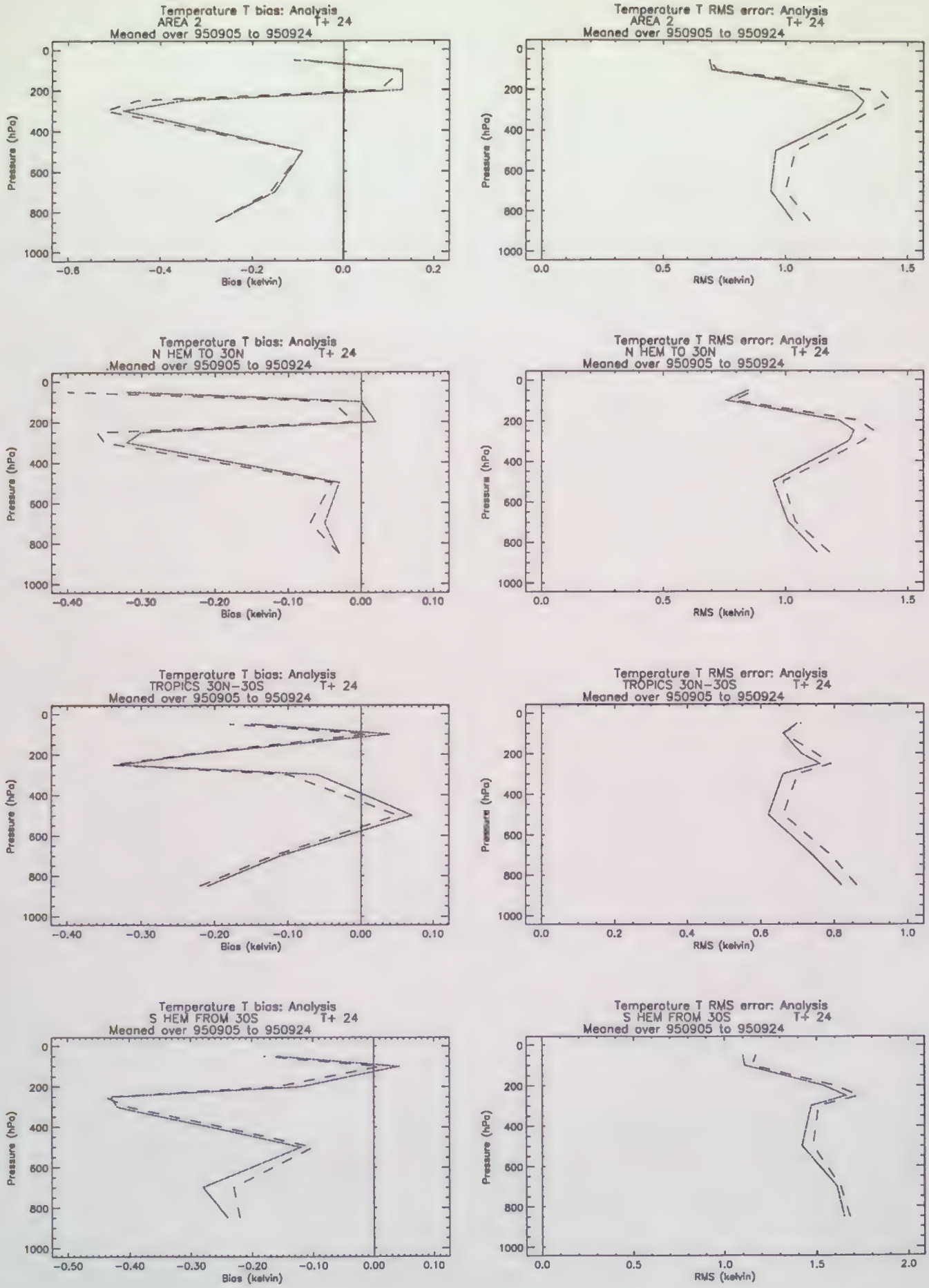

Temperature T bias: Analysis
AREA 2 T+ 24
Meaned over 950905 to 950924
Pressure (hPa)
Bias (kelvin)
Temperature T RMS error: Analysis
AREA 2 T+ 24
Meaned over 950905 to 950924
Pressure (hPa)
RMS (kelvin)
Temperature T bias: Analysis
N HEM TO 30N T+ 24
Meaned over 950905 to 950924
Pressure (hPa)
Bias (kelvin)
Temperature T RMS error: Analysis
N HEM TO 30N T+ 24
Meaned over 950905 to 950924
Pressure (hPa)
RMS (kelvin)
Temperature T bias: Analysis
TROPICS 30N-30S T+ 24
Meaned over 950905 to 950924
Pressure (hPa)
Bias (kelvin)
Temperature T RMS error: Analysis
TROPICS 30N-30S T+ 24
Meaned over 950905 to 950924
Pressure (hPa)
RMS (kelvin)
Temperature T bias: Analysis
S HEM FROM 30S T+ 24
Meaned over 950905 to 950924
Pressure (hPa)
Bias (kelvin)
Temperature T RMS error: Analysis
S HEM FROM 30S T+ 24
Meaned over 950905 to 950924
Pressure (hPa)
RMS (kelvin)

FIGURE 3.6

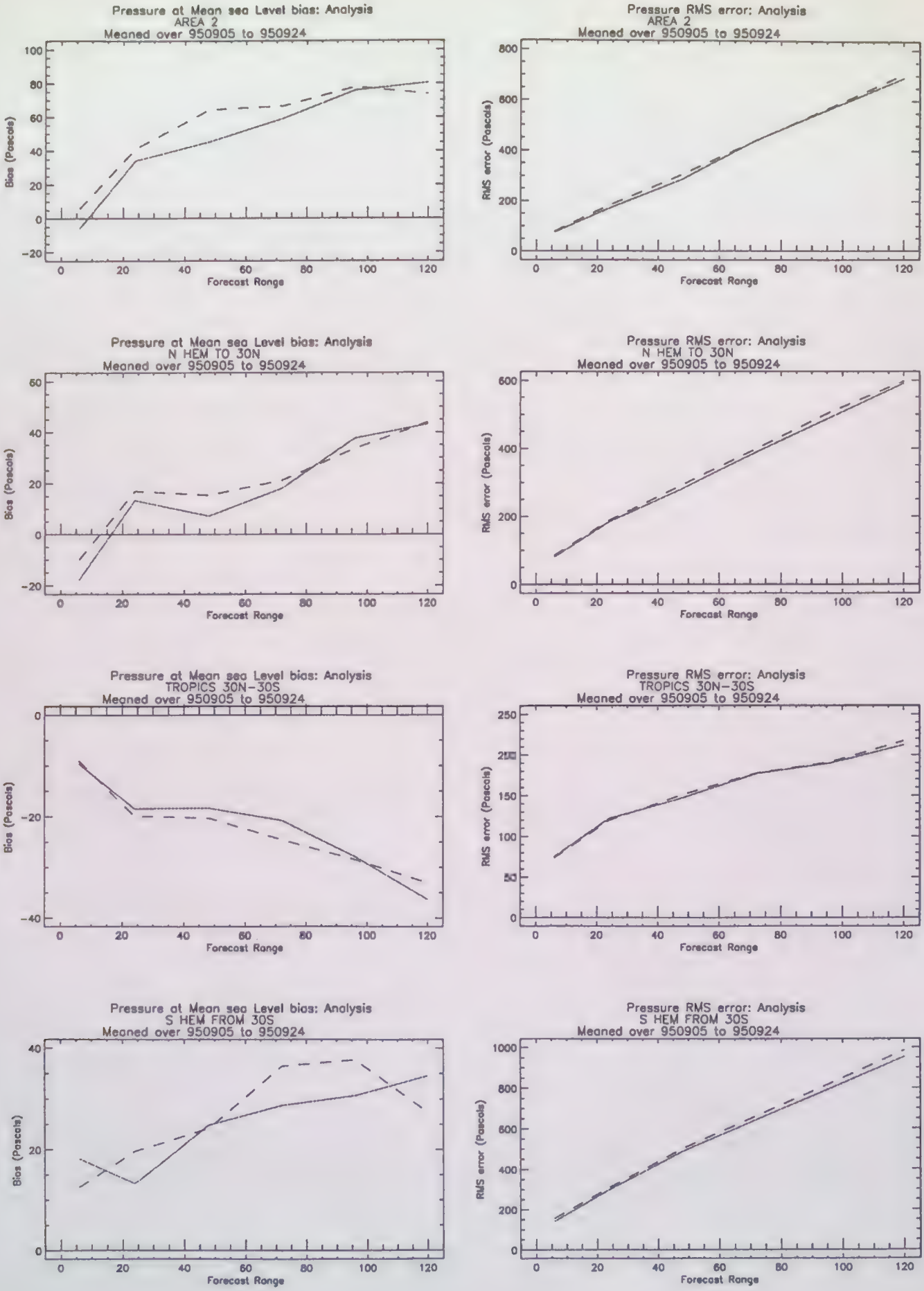
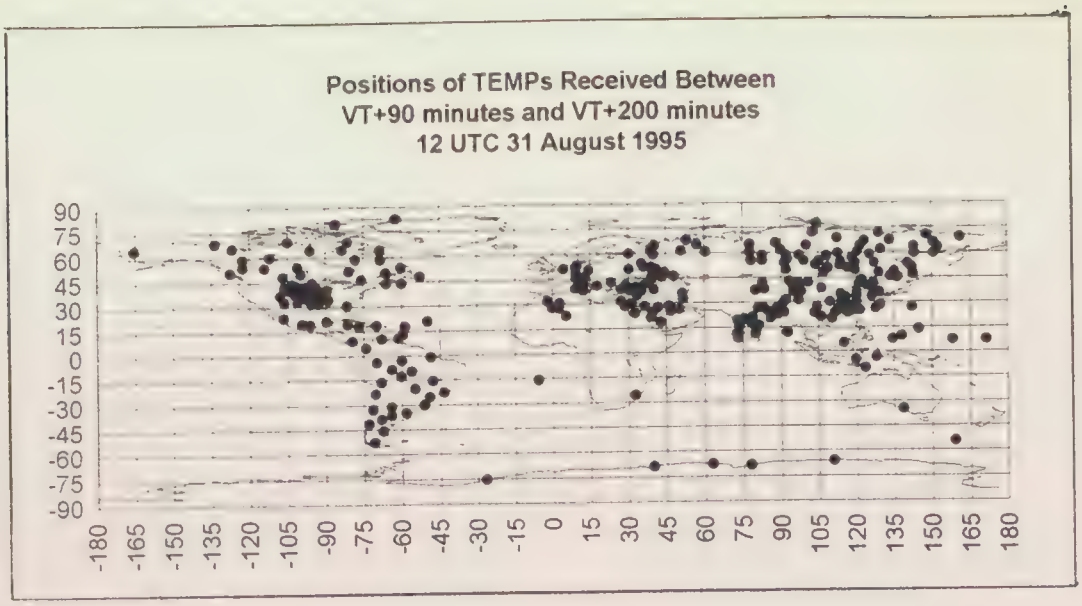
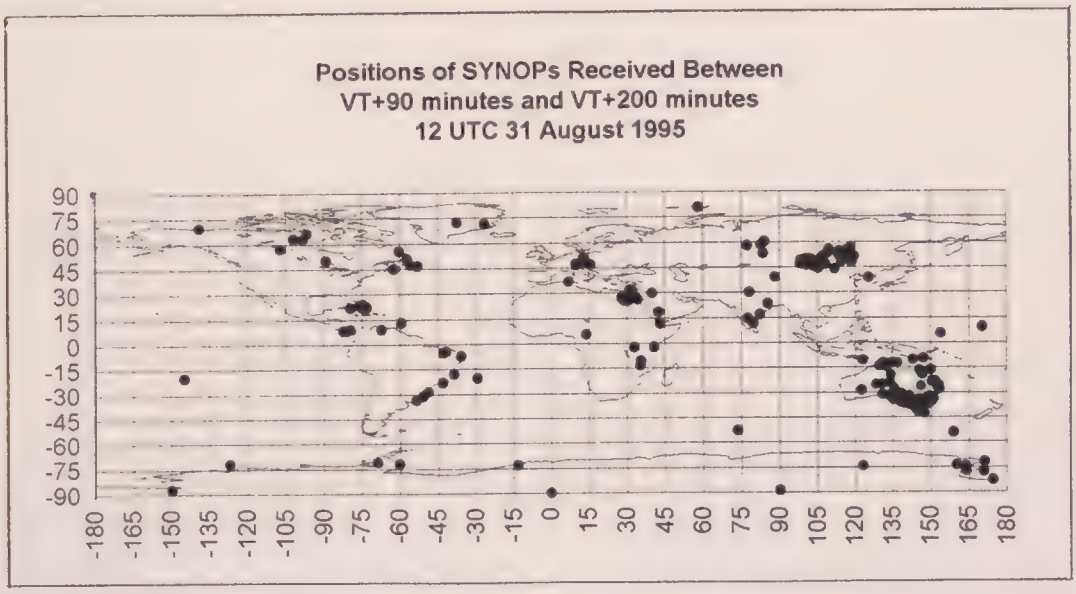

Pressure at Mean sea Level bias: Analysis
AREA 2
Meaned over 950905 to 950924
Bias (Pascals)
Forecast Range
Pressure RMS error: Analysis
AREA 2
Meaned over 950905 to 950924
RMS error (Pascals)
Forecast Range
Pressure at Mean sea Level bias: Analysis
N HEM TO 30N
Meaned over 950905 to 950924
Bias (Pascals)
Forecast Range
Pressure RMS error: Analysis
N HEM TO 30N
Meaned over 950905 to 950924
RMS error (Pascals)
Forecast Range
Pressure at Mean sea Level bias: Analysis
TROPICS 30N-30S
Meaned over 950905 to 950924
Bias (Pascals)
Forecast Range
Pressure RMS error: Analysis
TROPICS 30N-30S
Meaned over 950905 to 950924
RMS error (Pascals)
Forecast Range
Pressure at Mean sea Level bias: Analysis
S HEM FROM 30S
Meaned over 950905 to 950924
Bias (Pascals)
Forecast Range
Pressure RMS error: Analysis
S HEM FROM 30S
Meaned over 950905 to 950924
RMS error (Pascals)
Forecast Range

FIGURE 3.7


Positions of TEMPs Received Between
VT+90 minutes and VT+200 minutes
12 UTC 31 August 1995
90 75 60 45 30 15 0 -15 -30 -45 -60 -75 -90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180


Positions of SYNOPs Received Between
VT+90 minutes and VT+200 minutes
12 UTC 31 August 1995
90 75 60 45 30 15 0 -15 -30 -45 -60 -75 -90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180

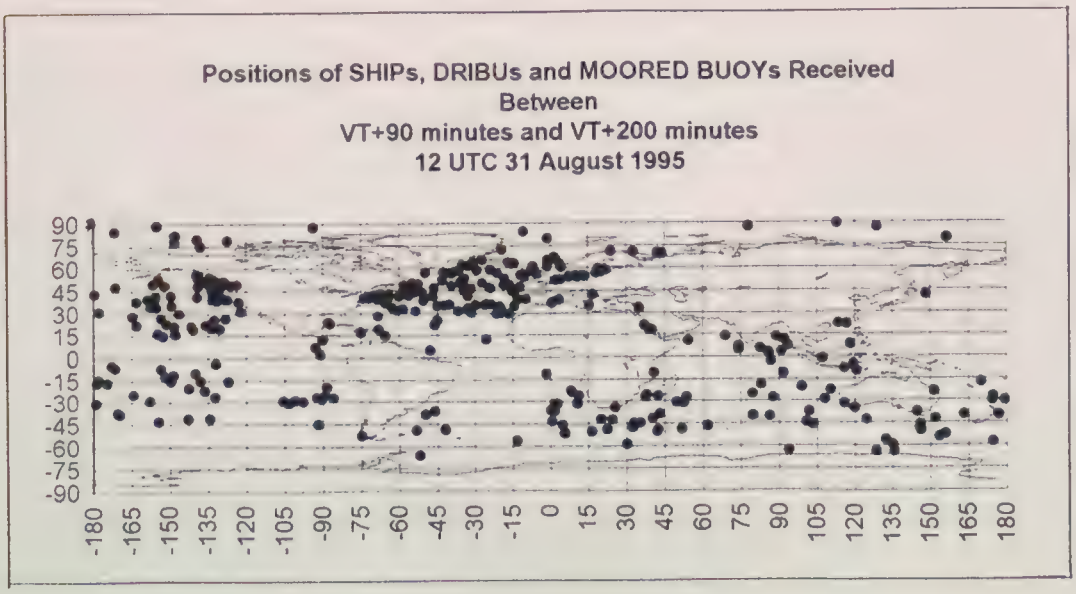
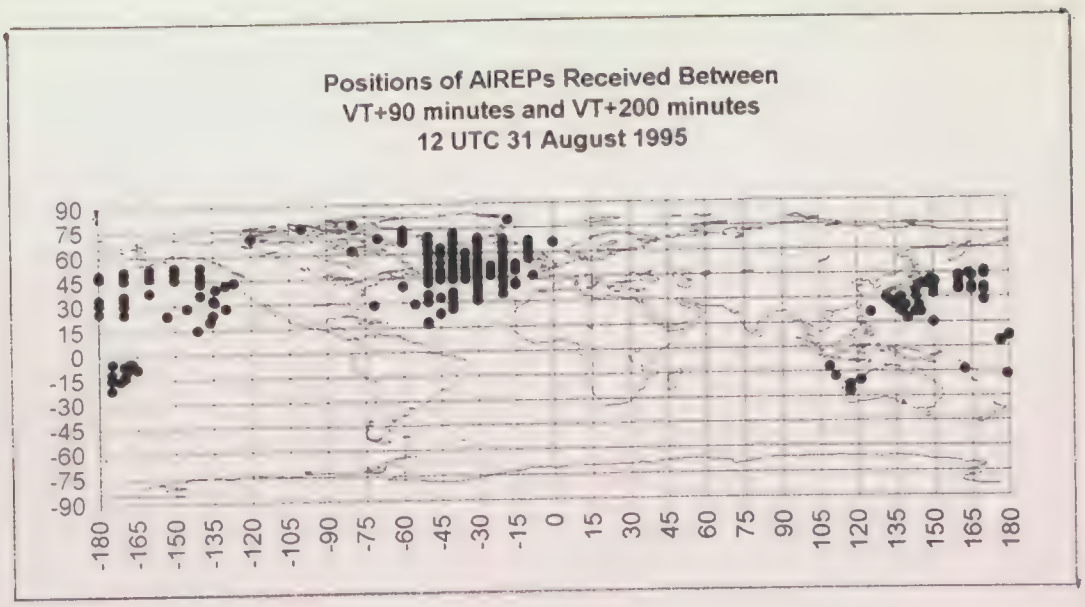

Positions of SHIPs, DRIBUs and MOORED BUOYs Received
Between
VT+90 minutes and VT+200 minutes
12 UTC 31 August 1995
90 75 60 45 30 15 0 -15 -30 -45 -60 -75 -90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180

Figure 4.1


Positions of AIREPs Received Between
VT+90 minutes and VT+200 minutes
12 UTC 31 August 1995
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180

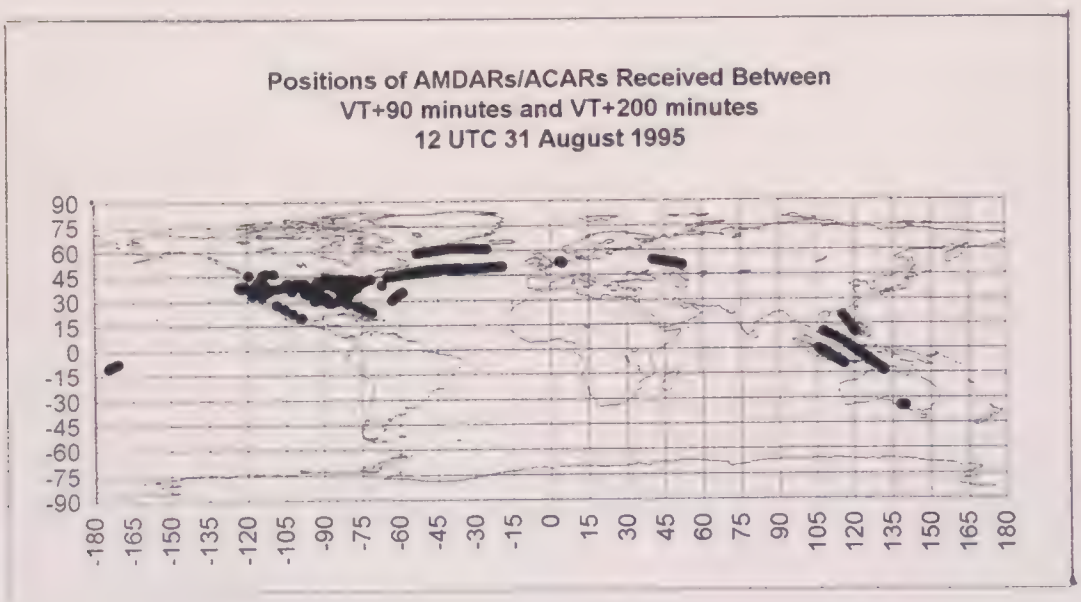
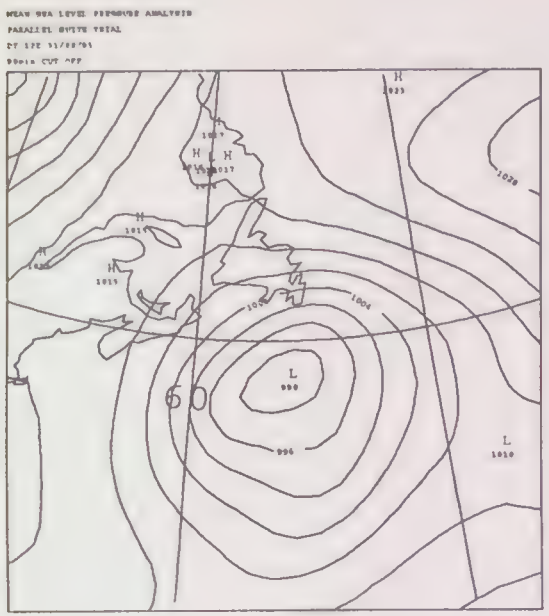
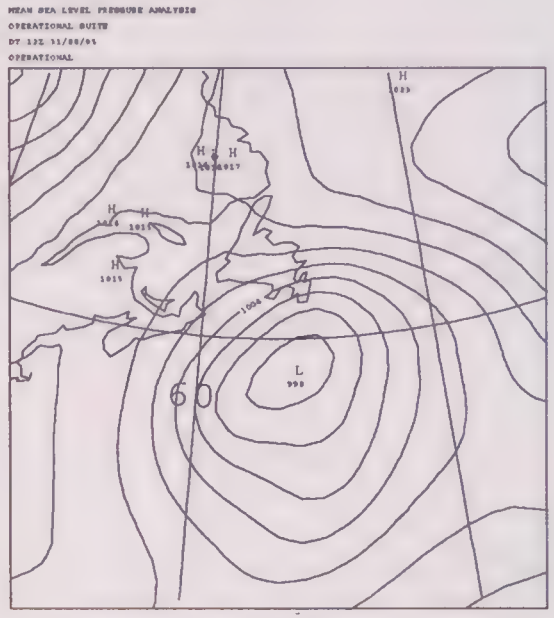

Positions of AMDARs/ACARs Received Between
VT+90 minutes and VT+200 minutes
12 UTC 31 August 1995
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180

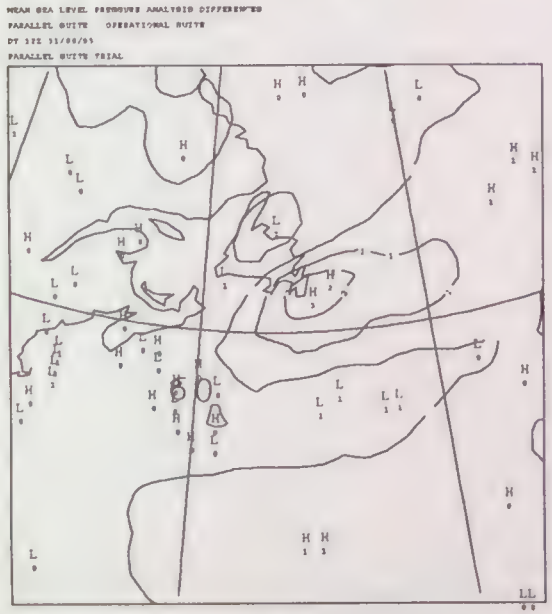
Figure 4.2



(a)

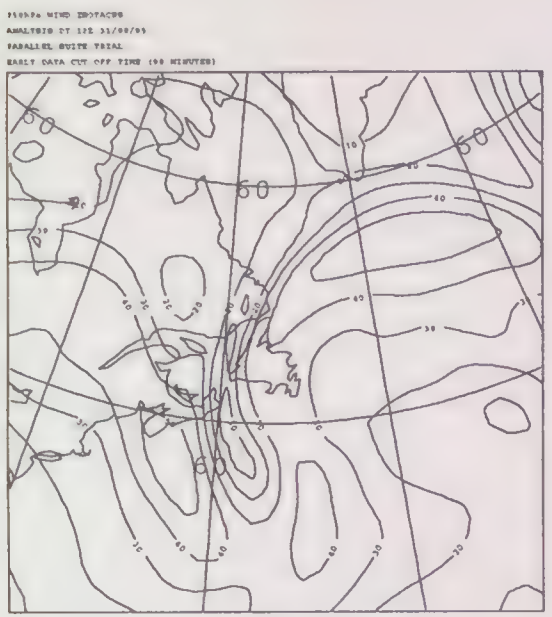


(b)

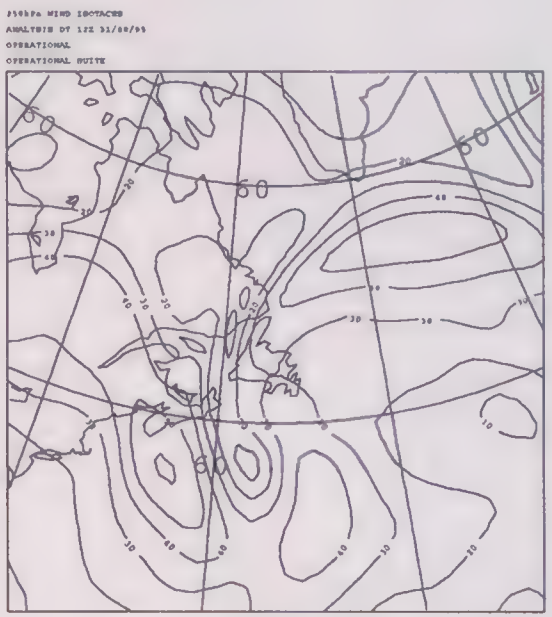


(c)

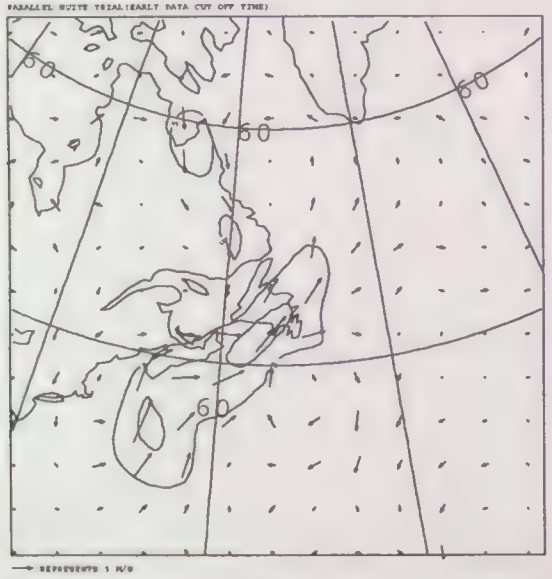
Figure 4.3



(a)

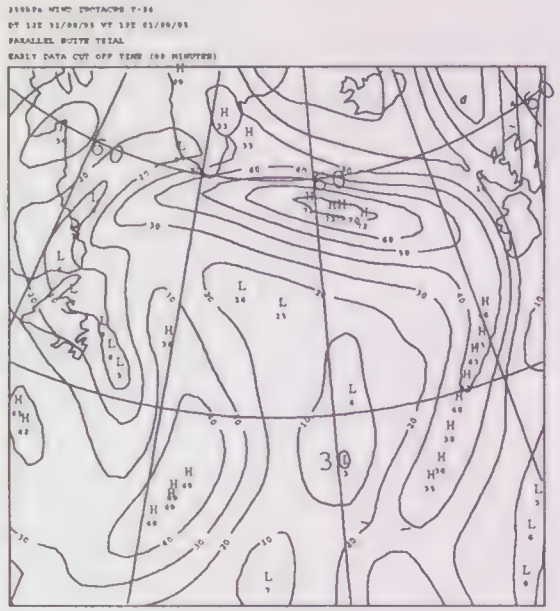


(b)

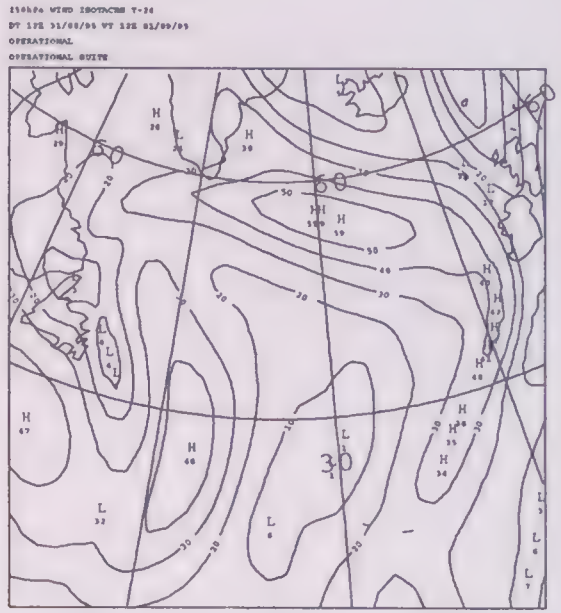


(c)

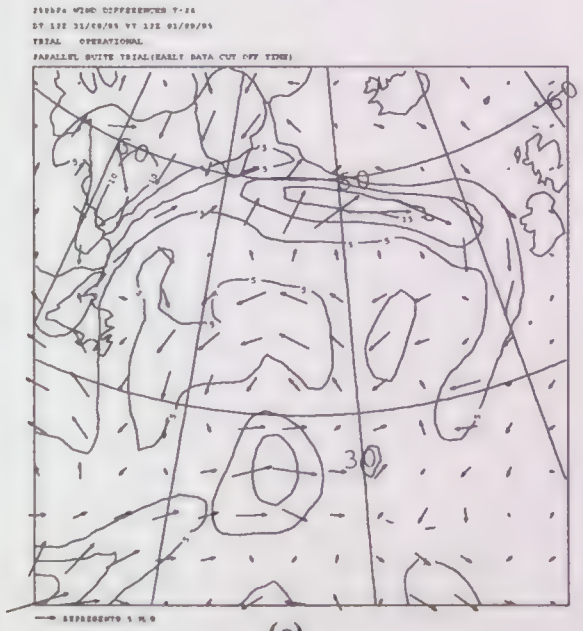
Figure 4.4



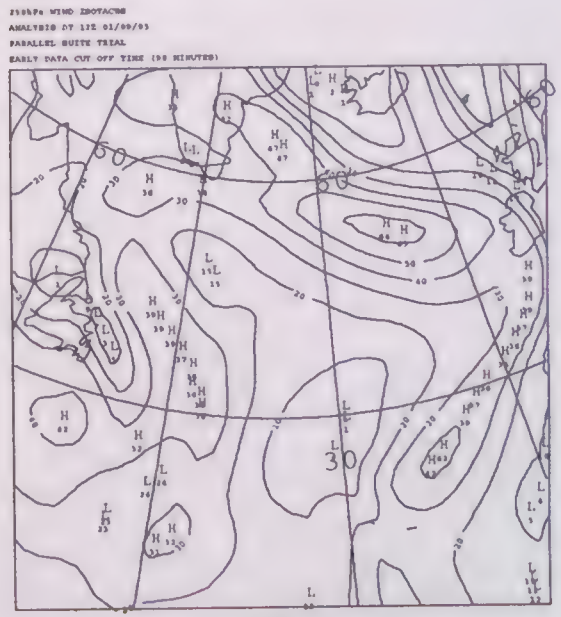
(a)



(b)



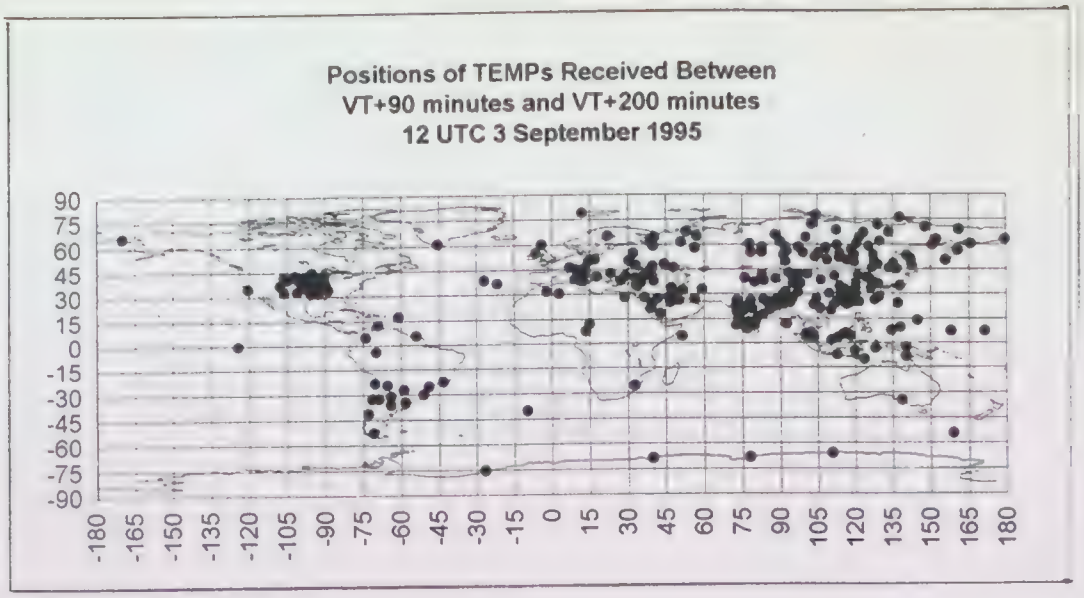
(c)

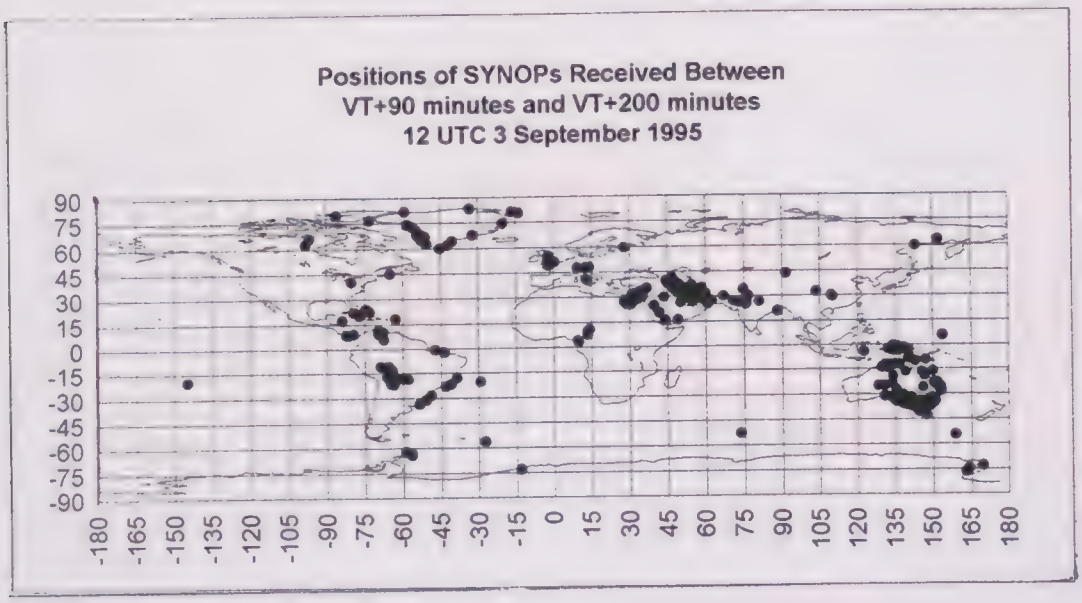


(d)

Figure 4.5

Figure 4.6


Positions of TEMPs Received Between
VT+90 minutes and VT+200 minutes
12 UTC 3 September 1995
90 75 60 45 30 15 0 -15 -30 -45 -60 -75 -90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180


Positions of SYNOPs Received Between
VT+90 minutes and VT+200 minutes
12 UTC 3 September 1995
90 75 60 45 30 15 0 -15 -30 -45 -60 -75 -90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180

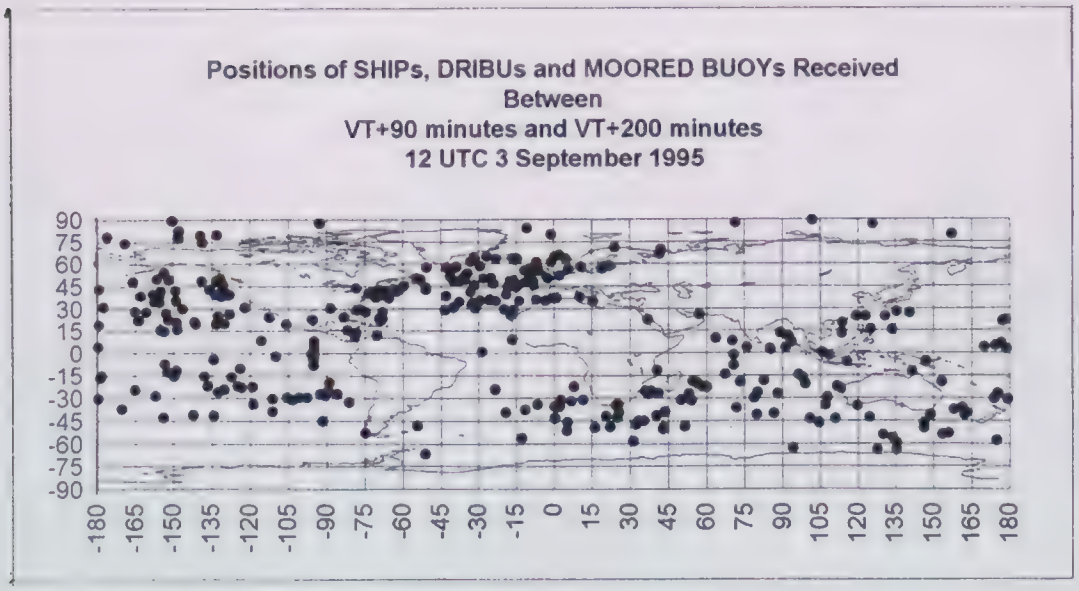
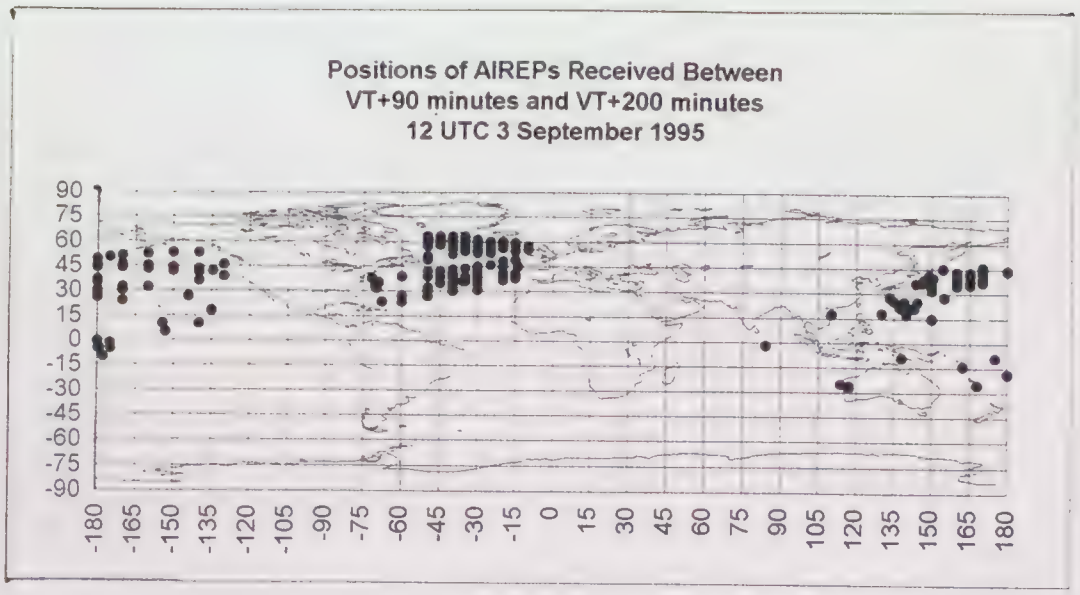

Positions of SHIPs, DRIBUs and MOORED BUOYs Received
Between
VT+90 minutes and VT+200 minutes
12 UTC 3 September 1995
90 75 60 45 30 15 0 -15 -30 -45 -60 -75 -90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180

Figure 4.7


Positions of AIREPs Received Between
VT+90 minutes and VT+200 minutes
12 UTC 3 September 1995
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180

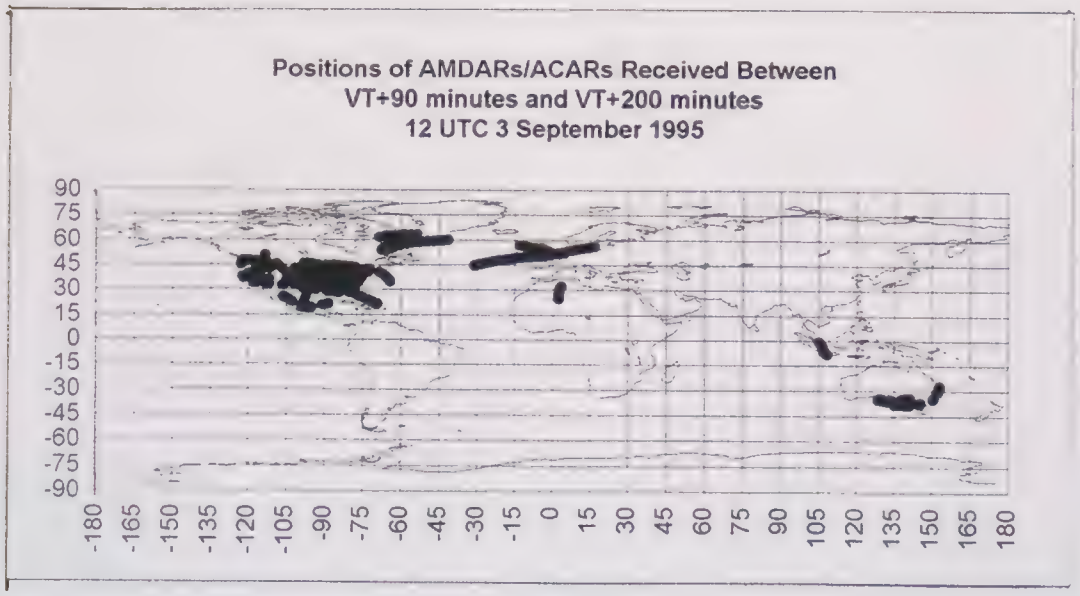
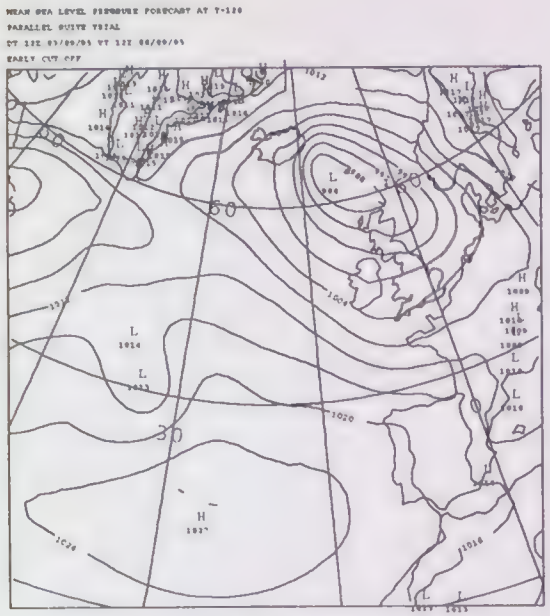
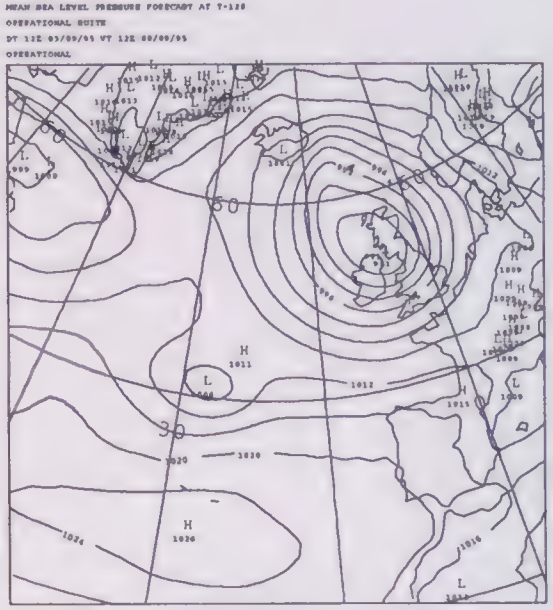

Positions of AMDARs/ACARs Received Between
VT+90 minutes and VT+200 minutes
12 UTC 3 September 1995
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180

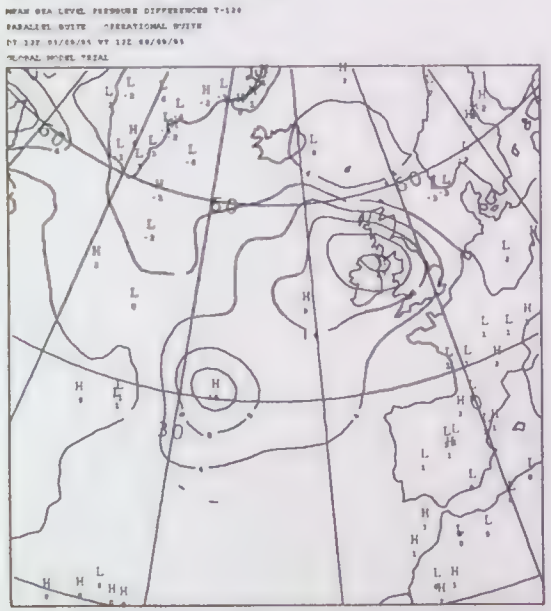
Figure 4.8



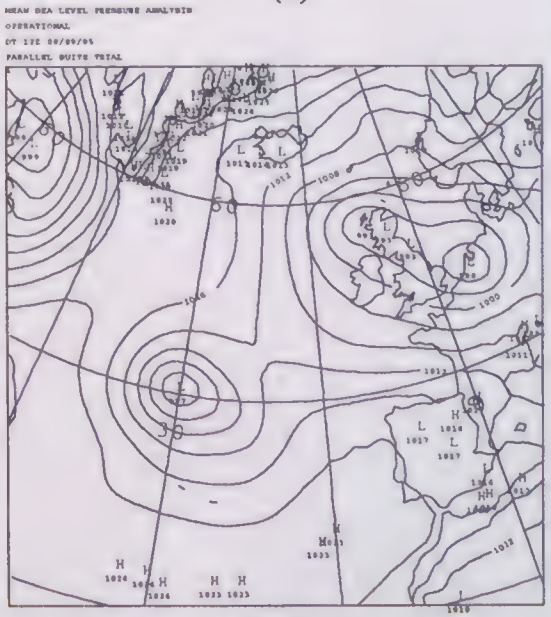
(a)



(b)

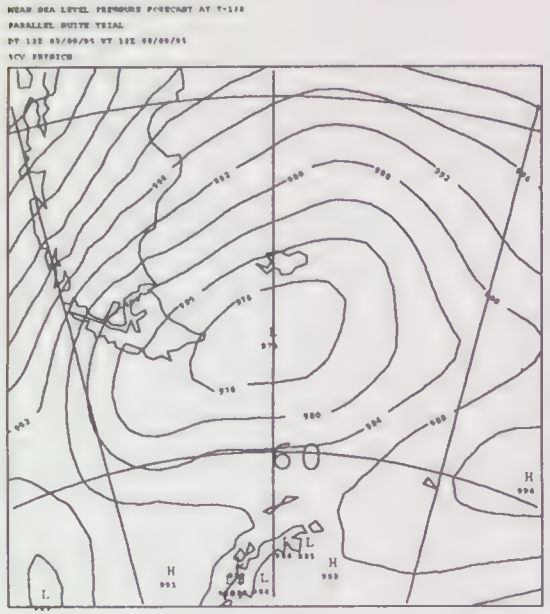


(c)

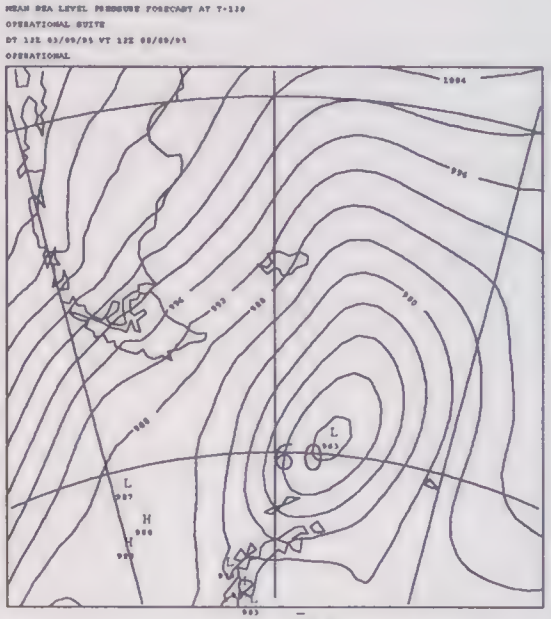


(d)

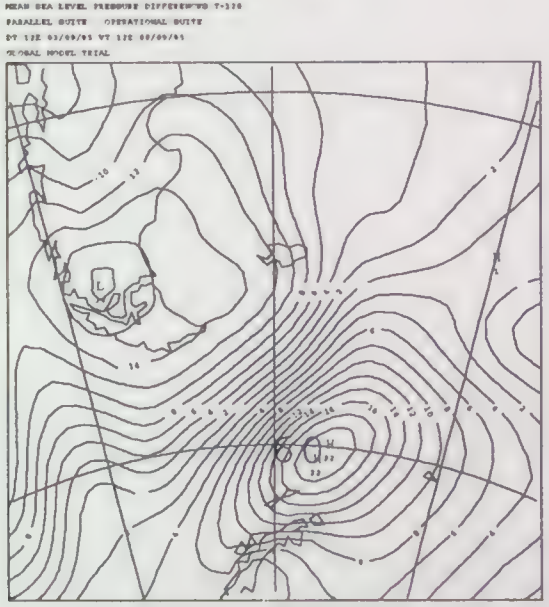
Figure 4.9



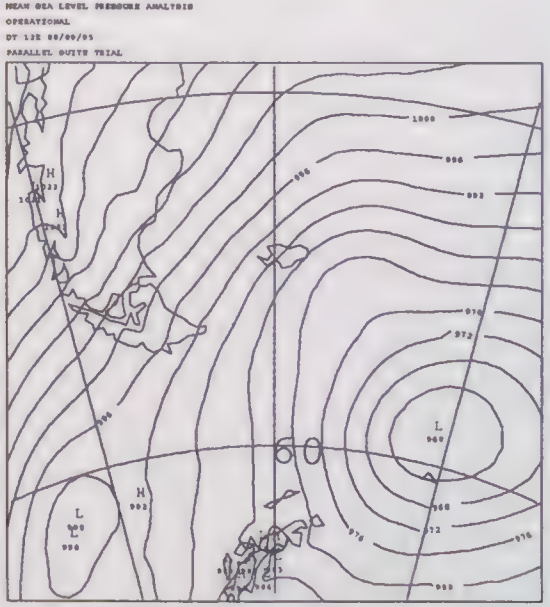
(a)



(b)

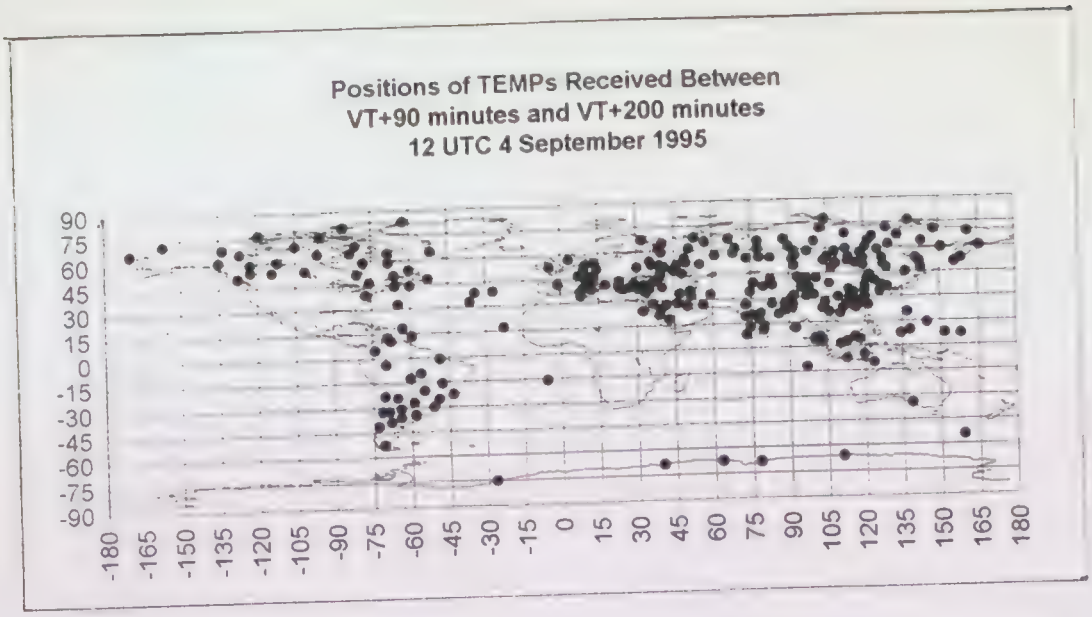


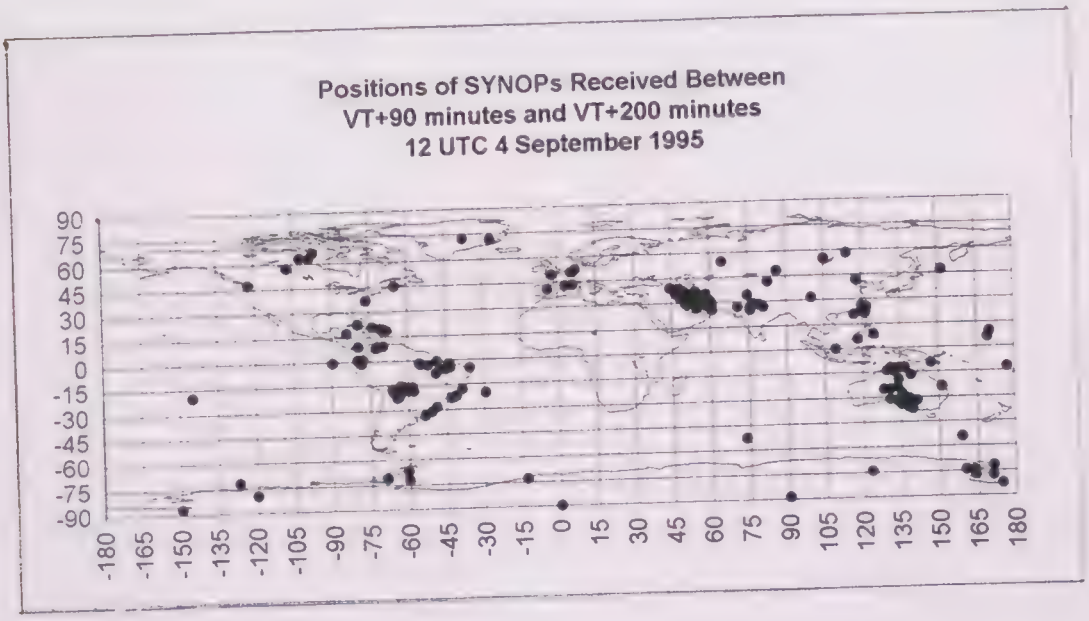
(c)



(d)

Figure 4.10


Positions of TEMPs Received Between
VT+90 minutes and VT+200 minutes
12 UTC 4 September 1995
90 75 60 45 30 15 0 -15 -30 -45 -60 -75 -90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180


Positions of SYNOPs Received Between
VT+90 minutes and VT+200 minutes
12 UTC 4 September 1995
90 75 60 45 30 15 0 -15 -30 -45 -60 -75 -90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180

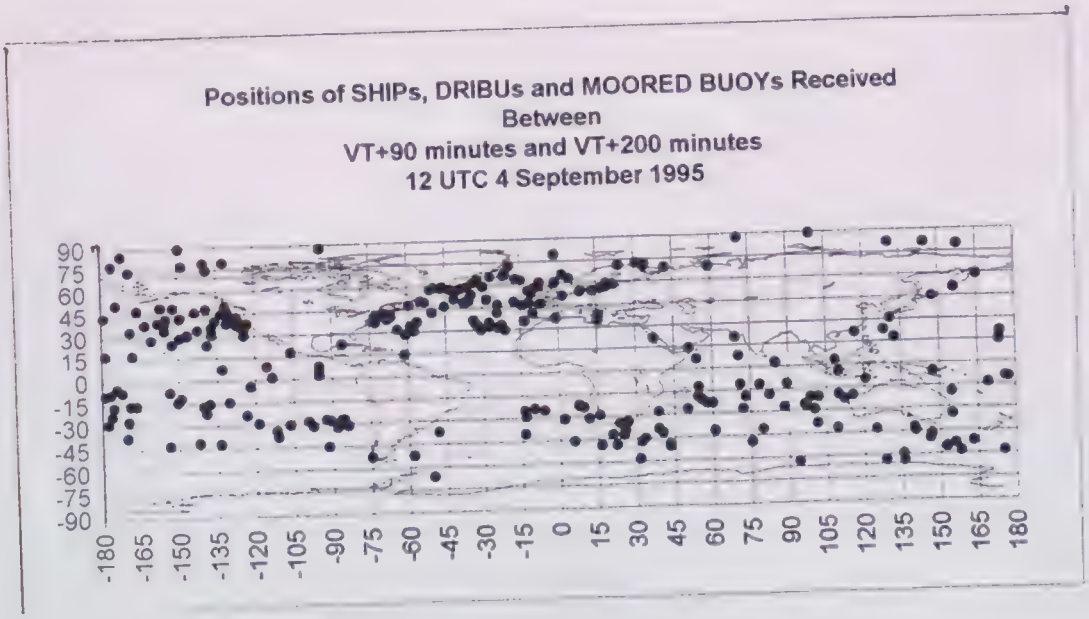
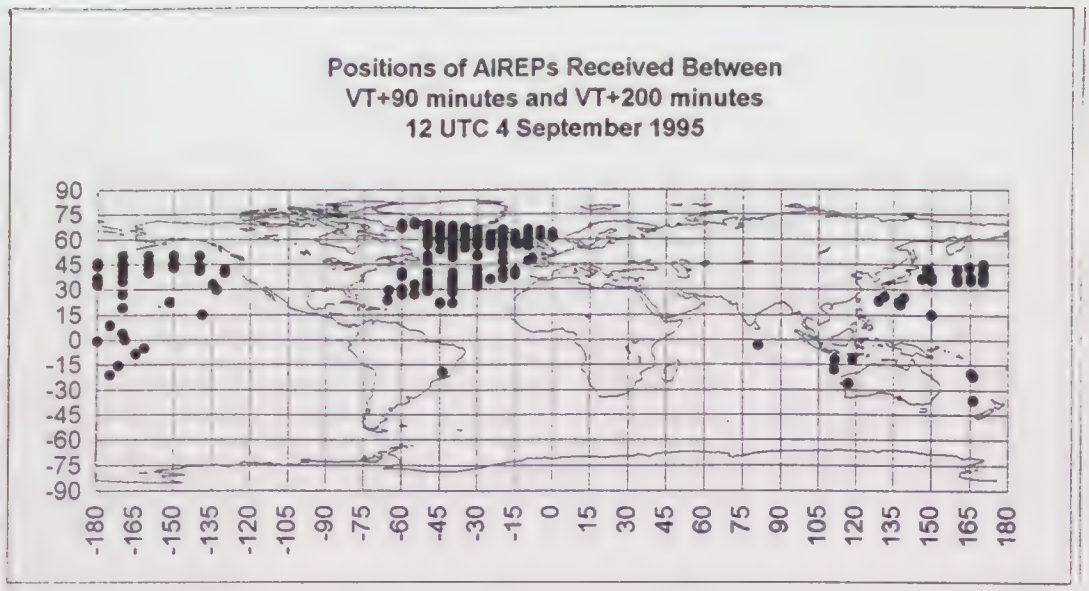

Positions of SHIPs, DRIBUs and MOORED BUOYs Received
Between
VT+90 minutes and VT+200 minutes
12 UTC 4 September 1995
90 75 60 45 30 15 0 -15 -30 -45 -60 -75 -90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180

Figure 4.11


Positions of AIREPs Received Between
VT+90 minutes and VT+200 minutes
12 UTC 4 September 1995
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180

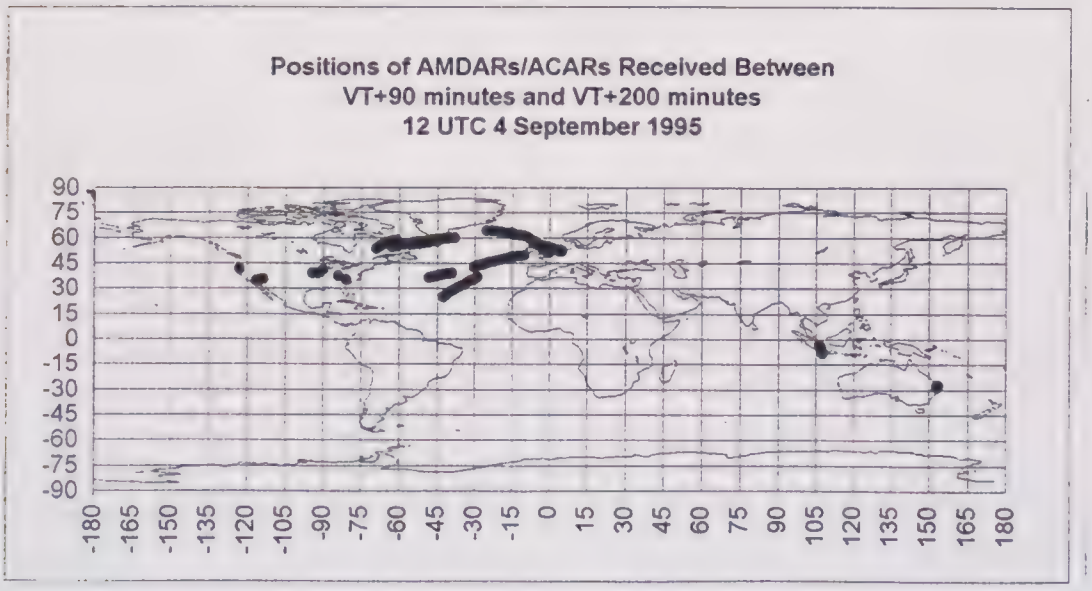
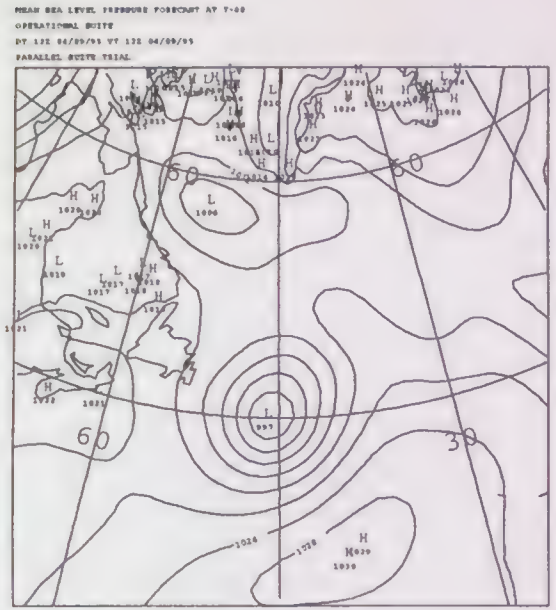
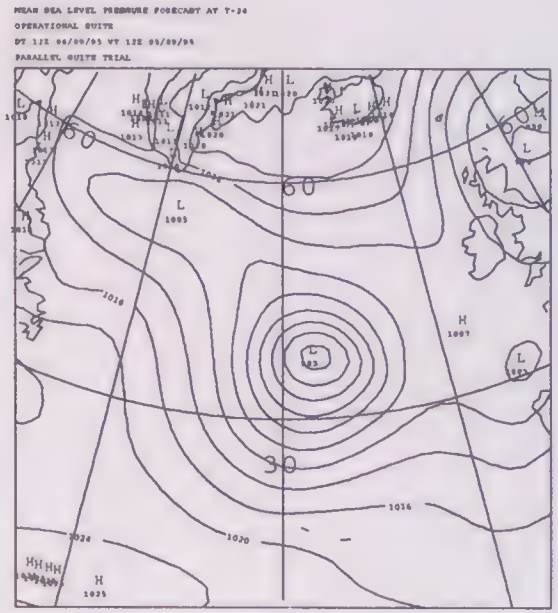

Positions of AMDARs/ACARs Received Between
VT+90 minutes and VT+200 minutes
12 UTC 4 September 1995
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
-180 -165 -150 -135 -120 -105 -90 -75 -60 -45 -30 -15 0 15 30 45 60 75 90 105 120 135 150 165 180

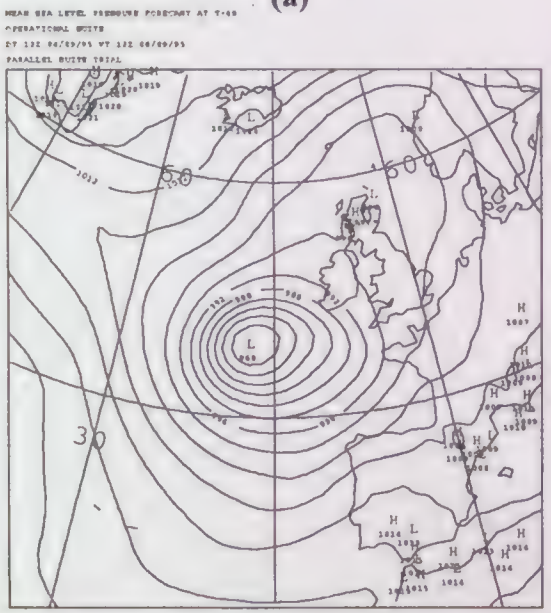
Figure 4.12



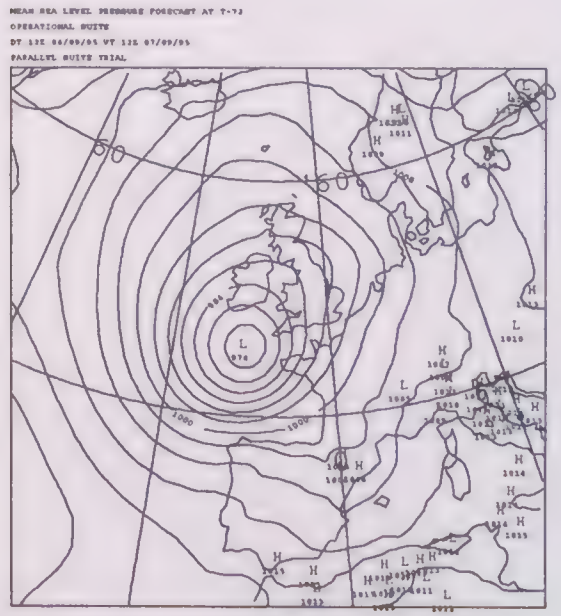
(a)



(b)

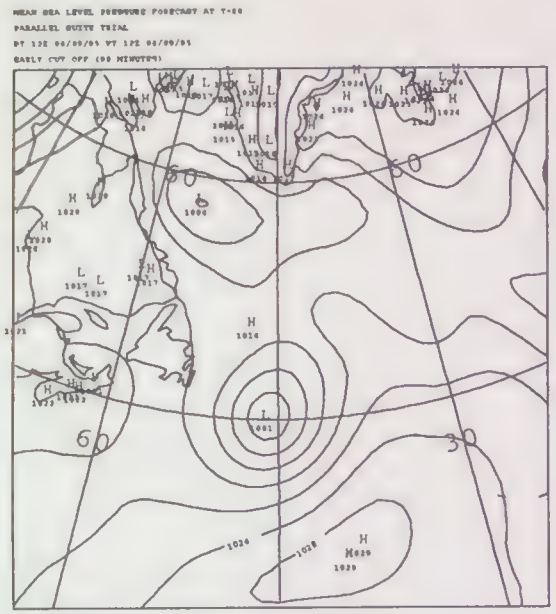


(c)

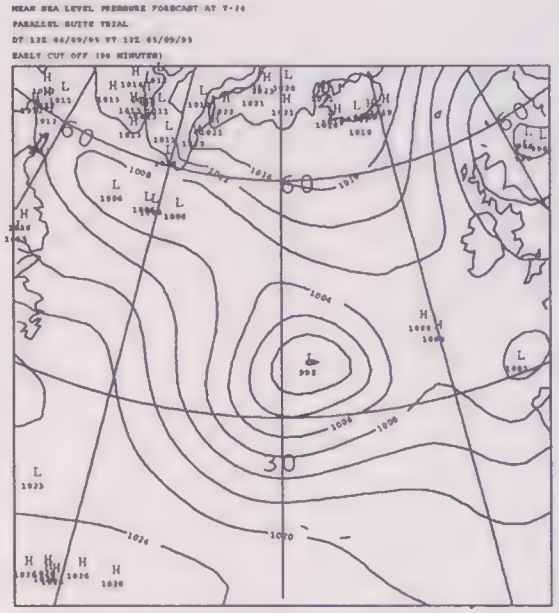


(d)

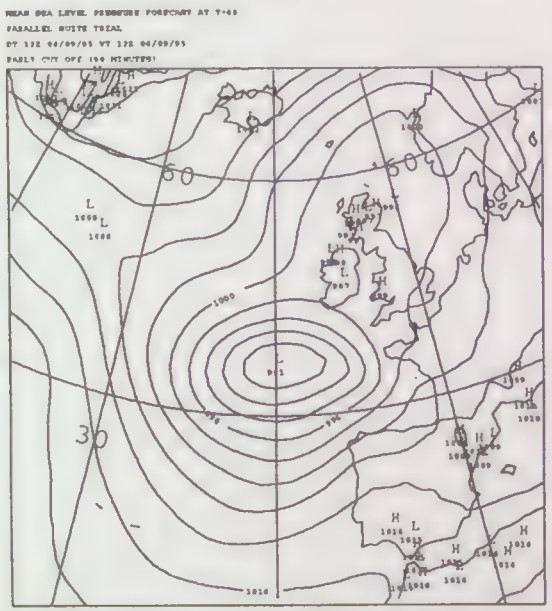
Figure 4.13



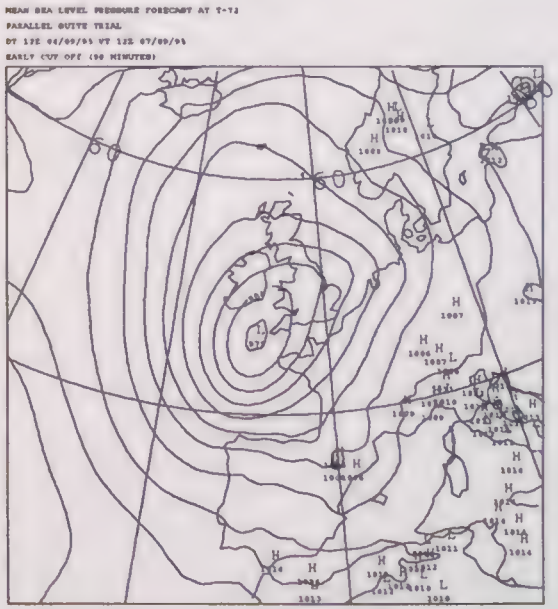
(a)



(b)

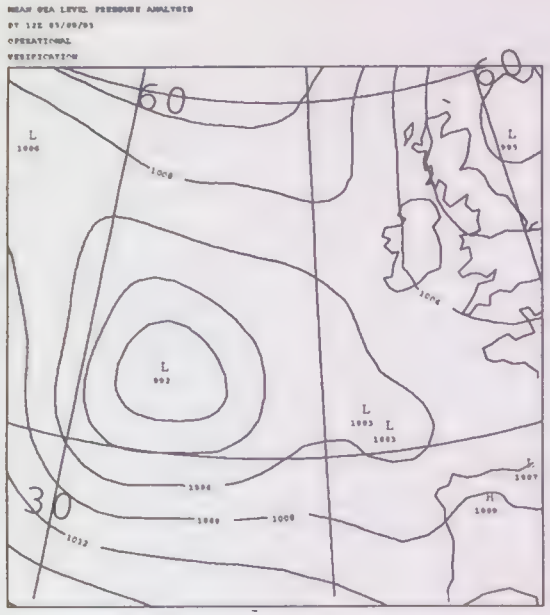


(c)

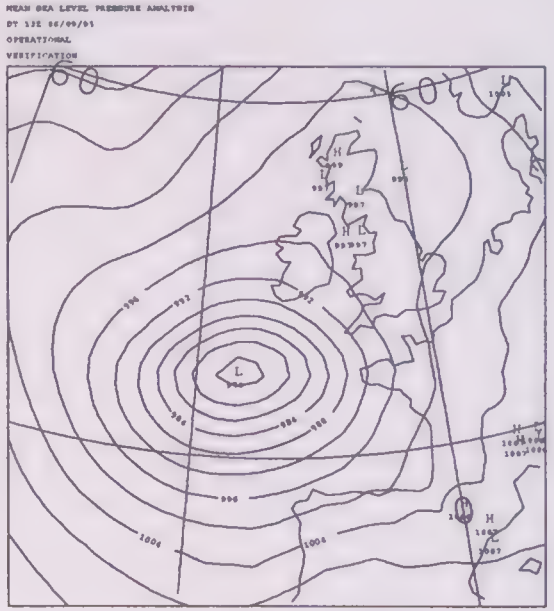


(d)

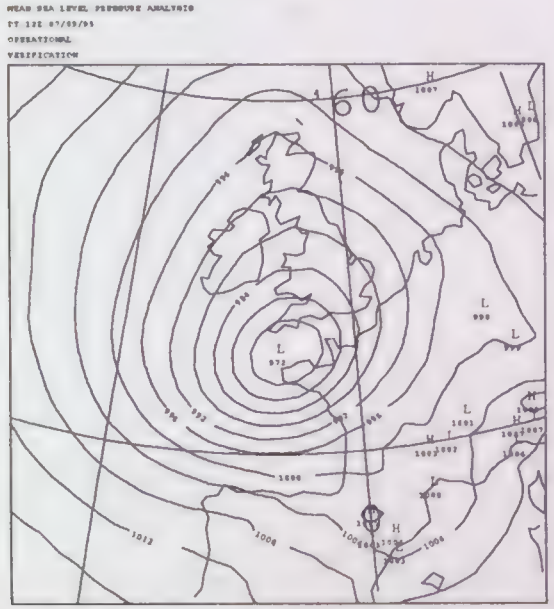
Figure 4.14



(a)

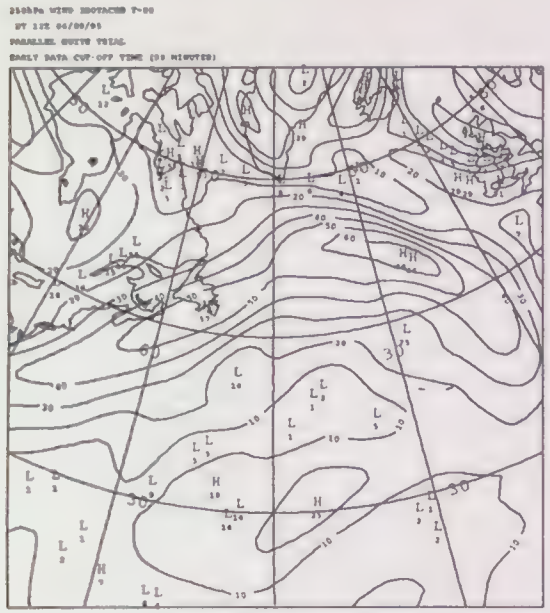


(b)

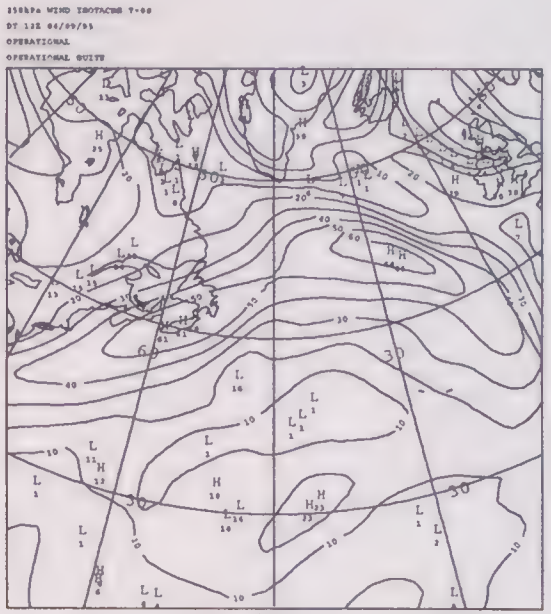


(c)

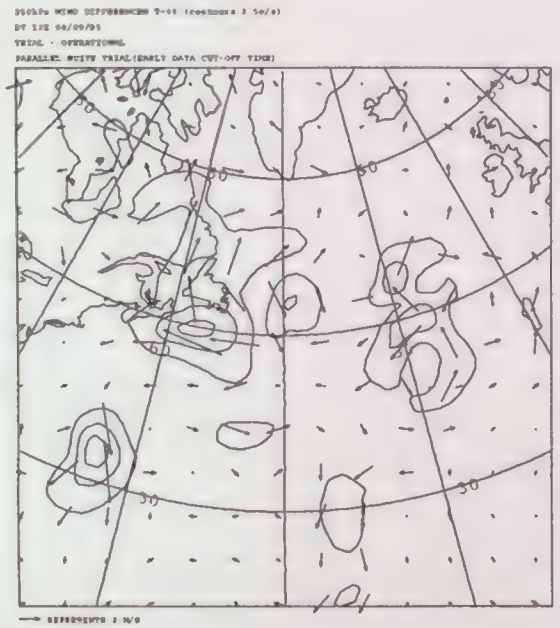
Figure 4.15



(a)

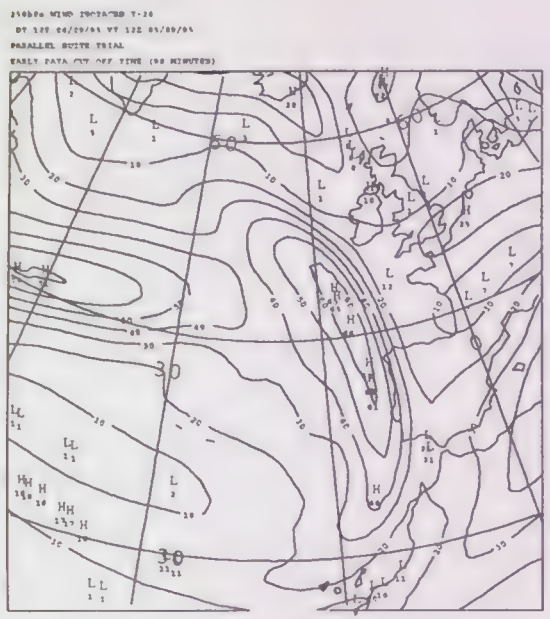


(b)

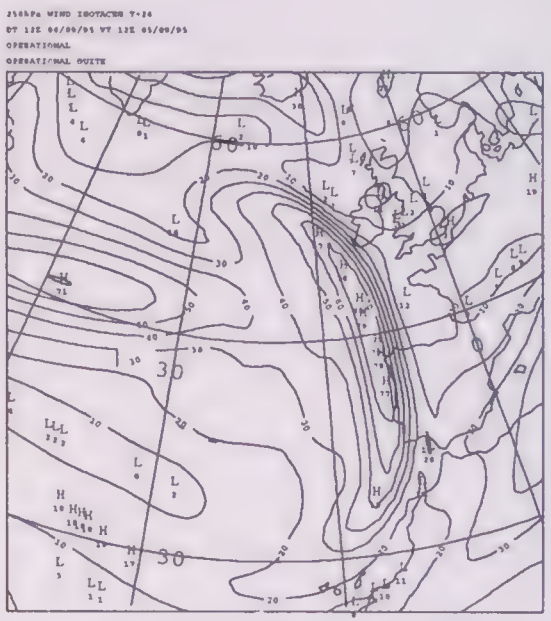


(c)

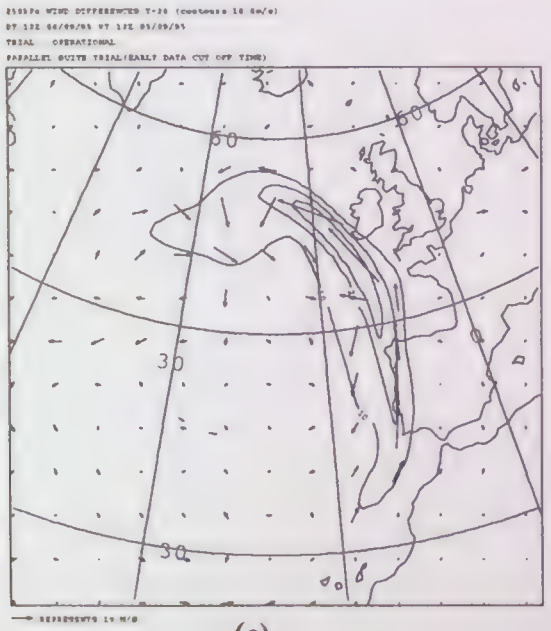
Figure 4.16



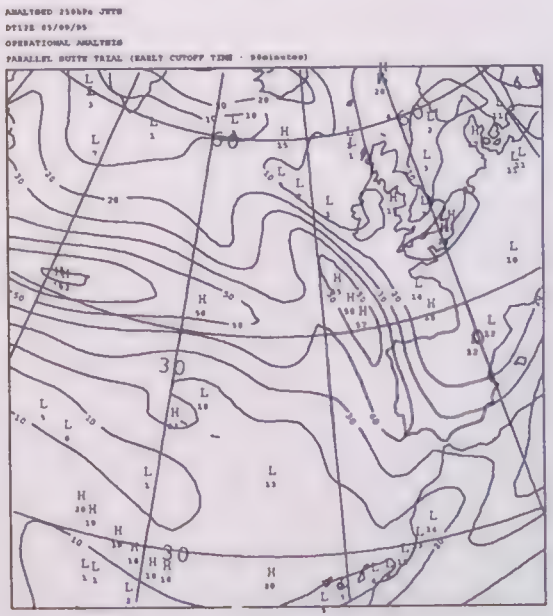
(a)



(b)



(c)



(d)

Figure 4.17

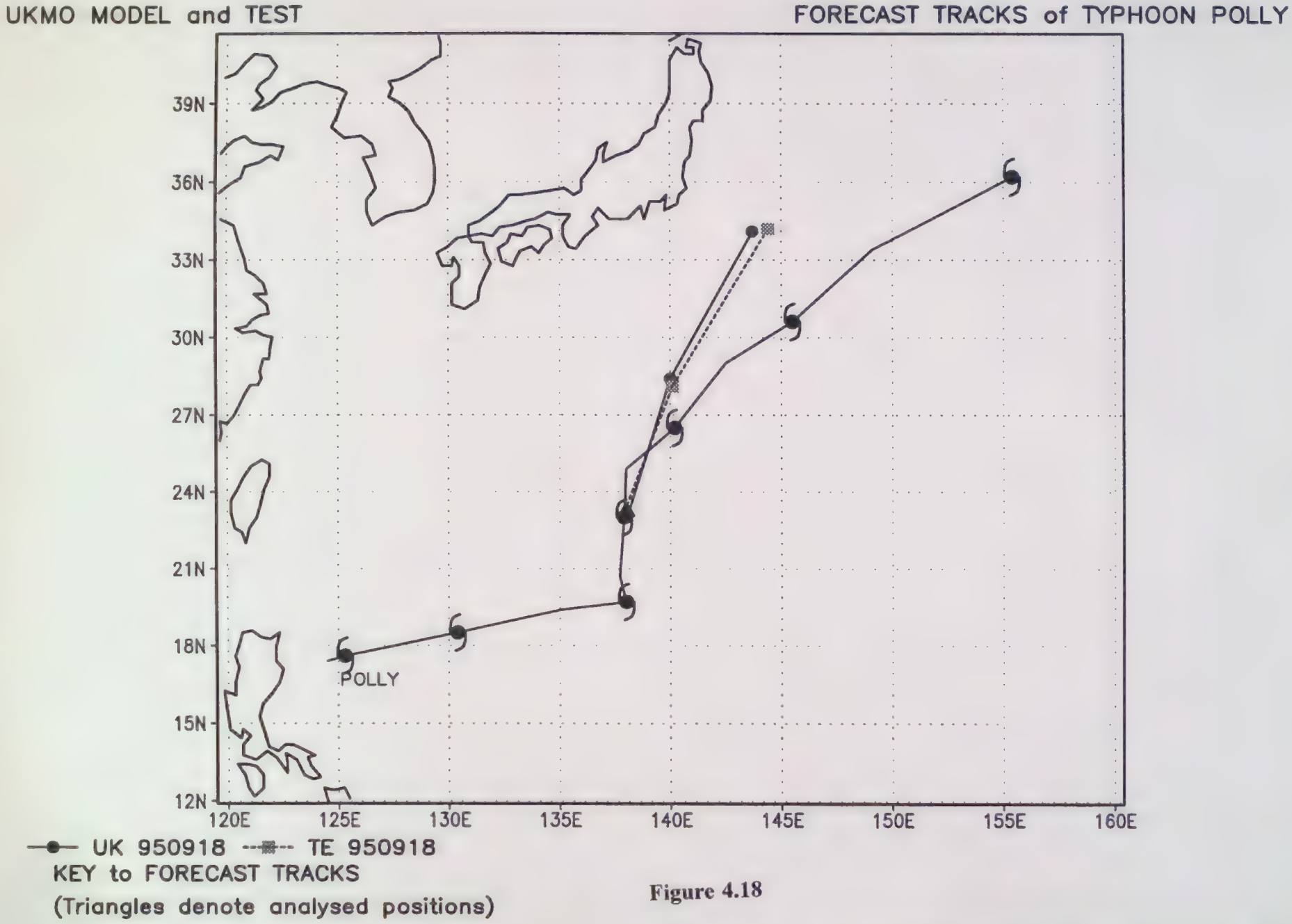
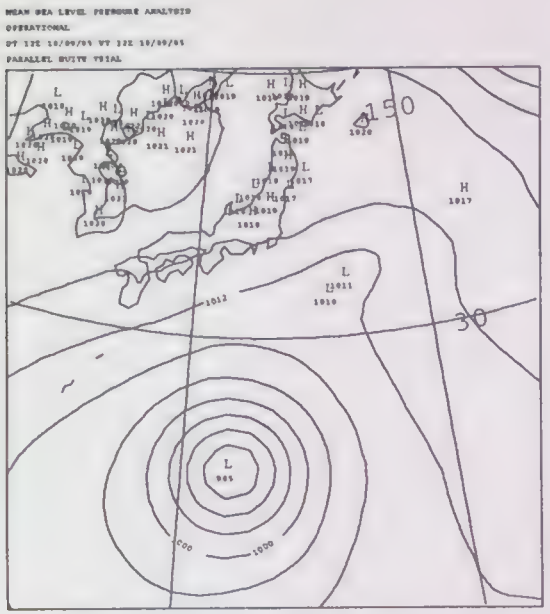
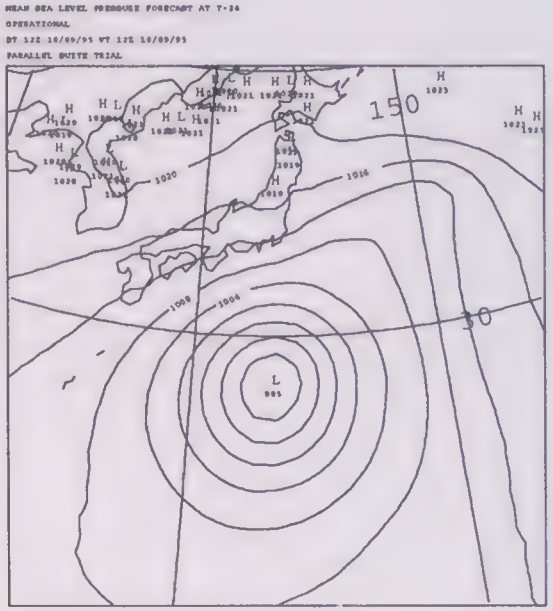

UKMO MODEL and TEST
FORECAST TRACKS of TYPHOON POLLY
39N
36N
33N
30N
27N
24N
21N
18N
15N
12N
120E
125E
130E
135E
140E
145E
150E
155E
160E
POLLY
UK 950918
TE 950918
KEY to FORECAST TRACKS
(Triangles denote analysed positions)
24 HOURLY OBSERVED POSITIONS
DATE/TIME OF FIRST SYMBOL 12Z 15 SEPTEMBER 1995

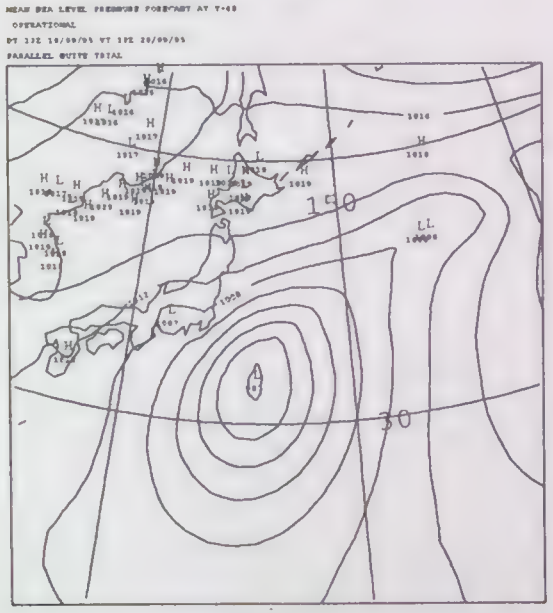
Figure 4.18



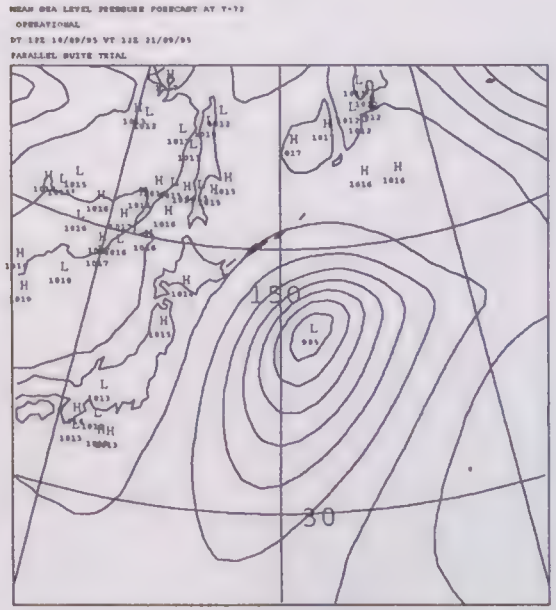
(a)



(b)

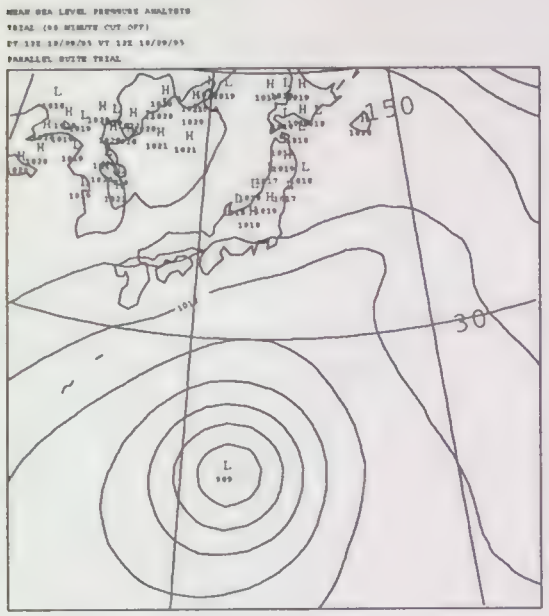


(c)

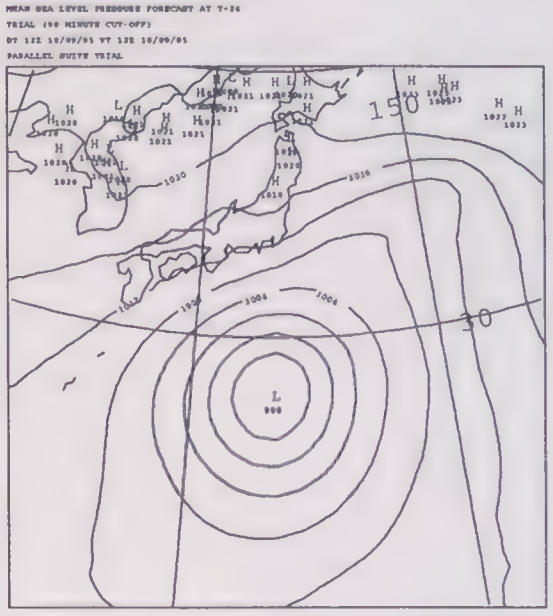


(d)

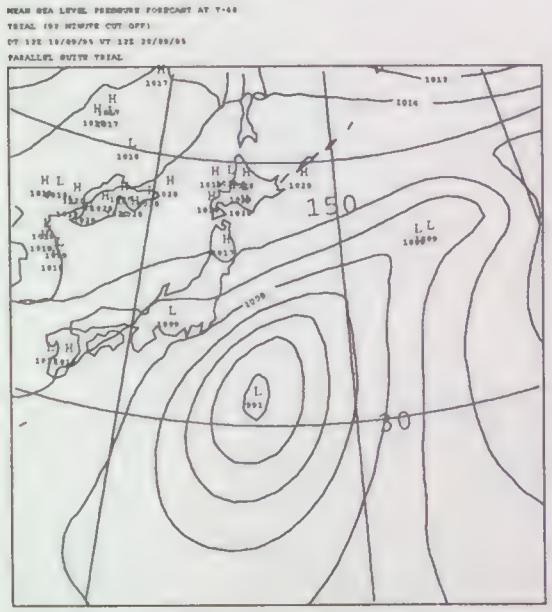
Figure 4.19



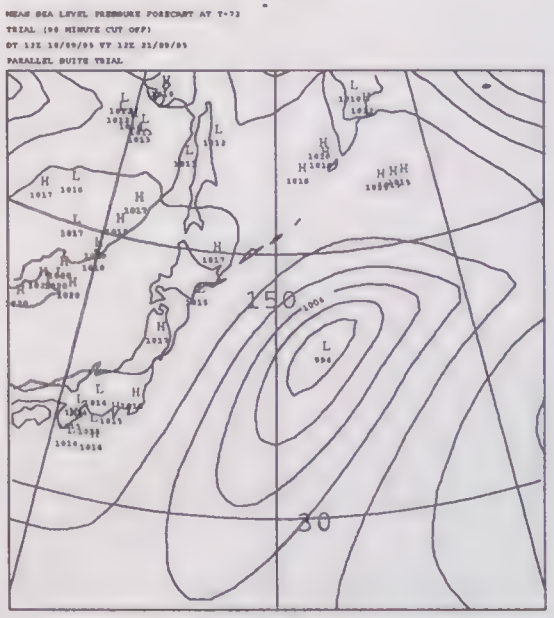
(a)



(b)

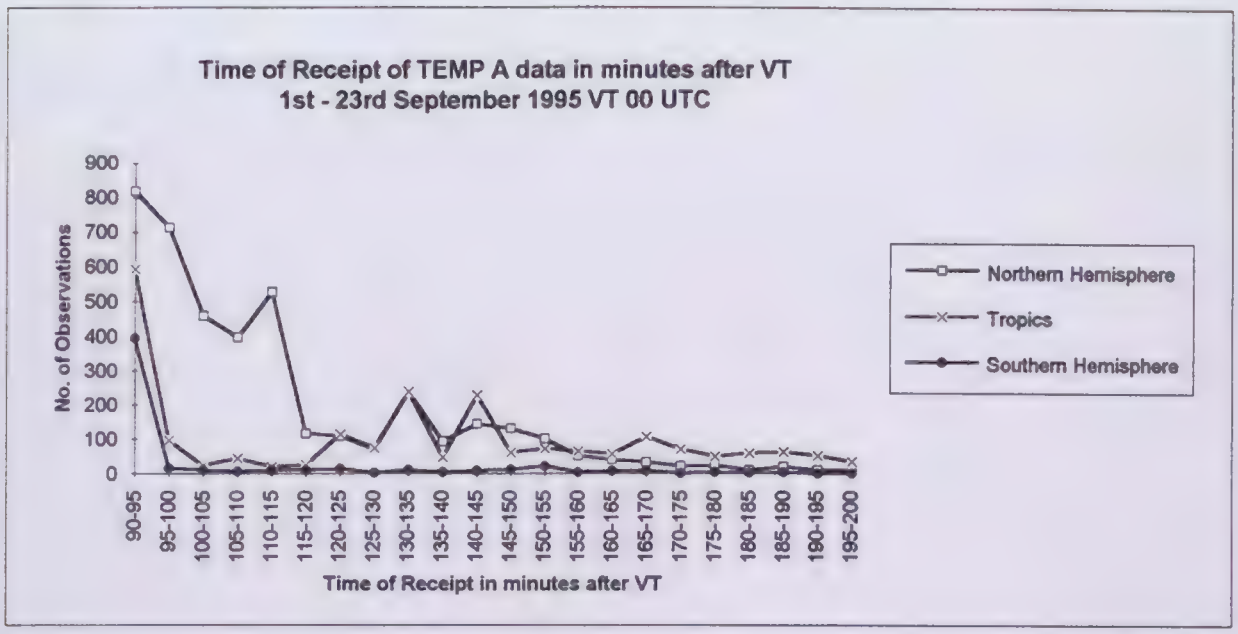


(c)



(d)

Figure 4.20


Time of Receipt of TEMP A data in minutes after VT
1st - 23rd September 1995 VT 00 UTC
No. of Observations
900
800
700
600
500
400
300
200
100
0
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

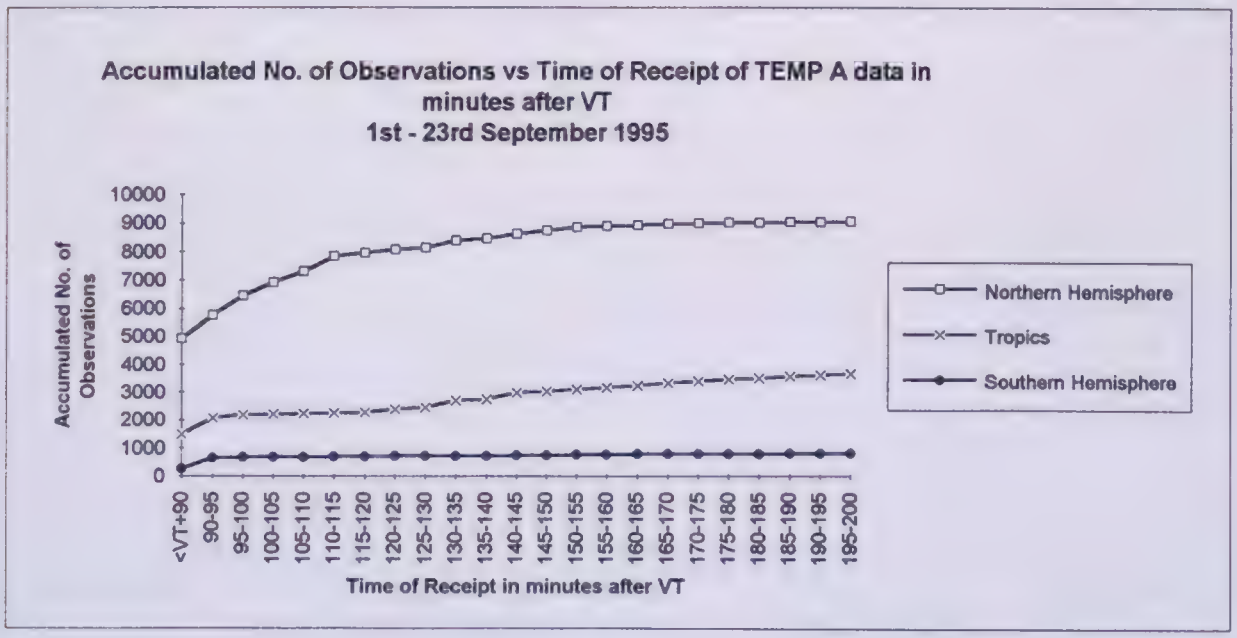
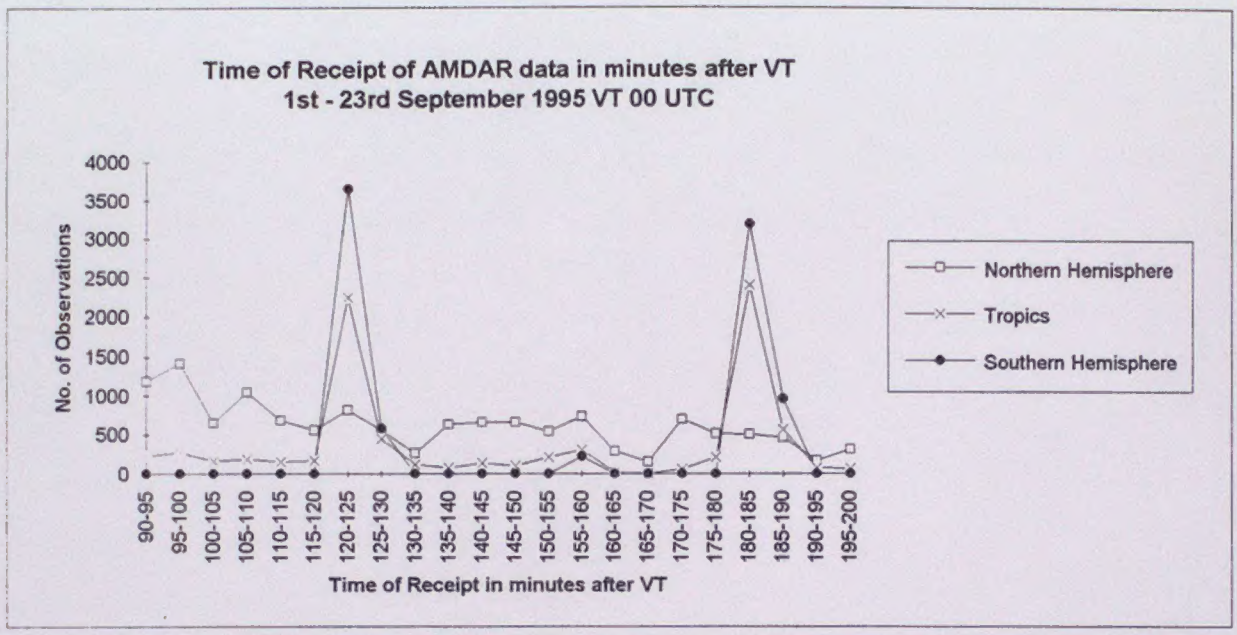

Accumulated No. of Observations vs Time of Receipt of TEMP A data in minutes after VT
1st - 23rd September 1995
Accumulated No. of Observations
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
<VT+90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

FIGURE A.1


Time of Receipt of AMDAR data in minutes after VT
1st - 23rd September 1995 VT 00 UTC
No. of Observations
4000
3500
3000
2500
2000
1500
1000
500
0
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

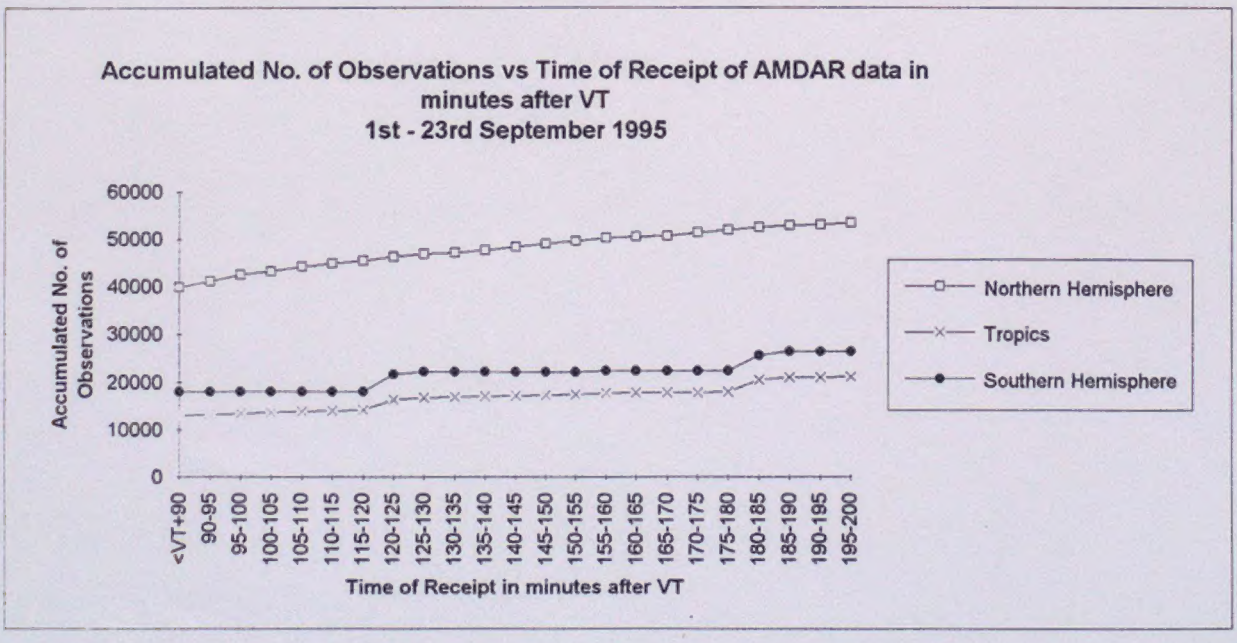
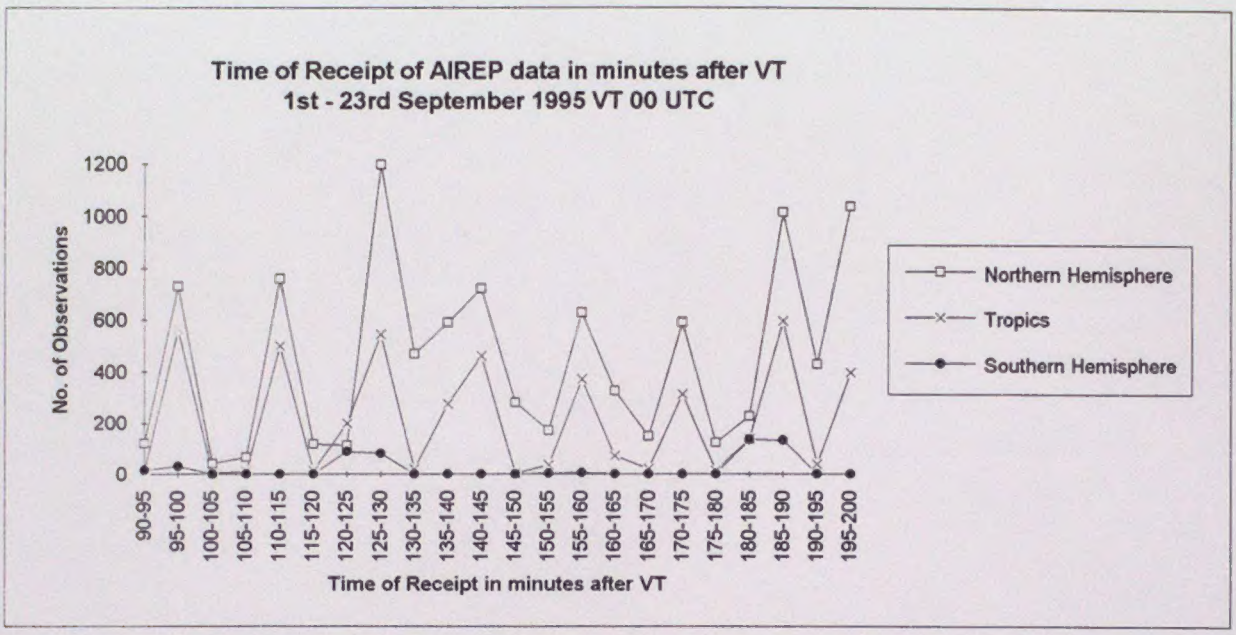

Accumulated No. of Observations vs Time of Receipt of AMDAR data in minutes after VT
1st - 23rd September 1995
Accumulated No. of Observations
60000
50000
40000
30000
20000
10000
0
<VT+90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

FIGURE A.2


Time of Receipt of AIREP data in minutes after VT
1st - 23rd September 1995 VT 00 UTC
No. of Observations
1200
1000
800
600
400
200
0
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

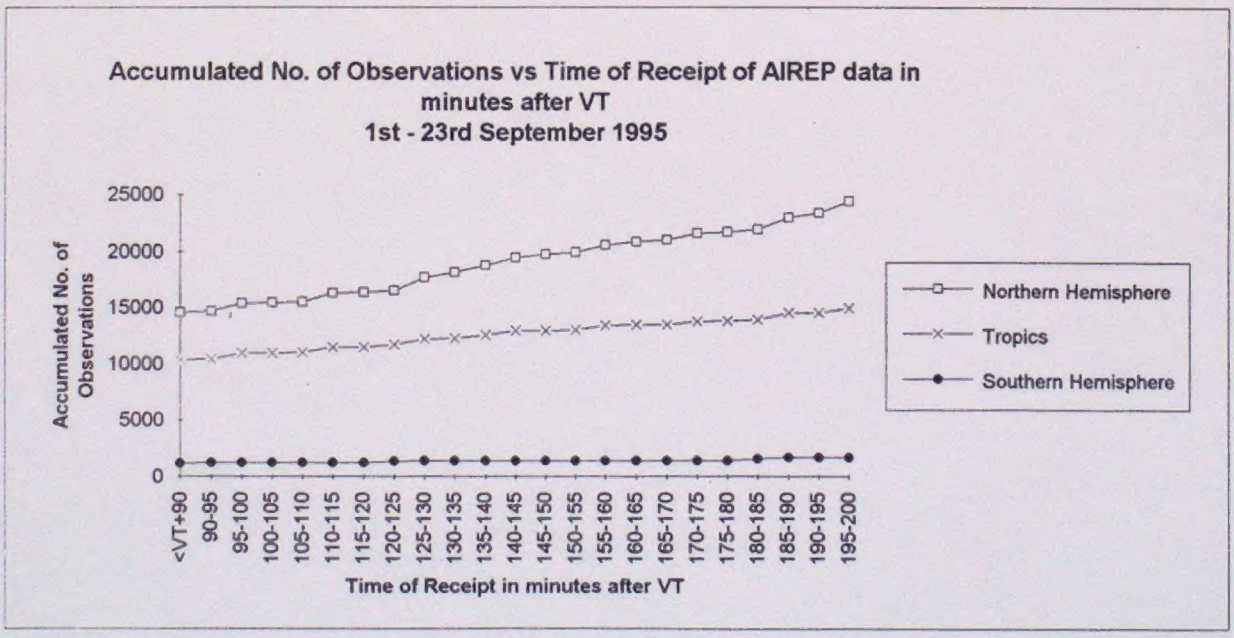
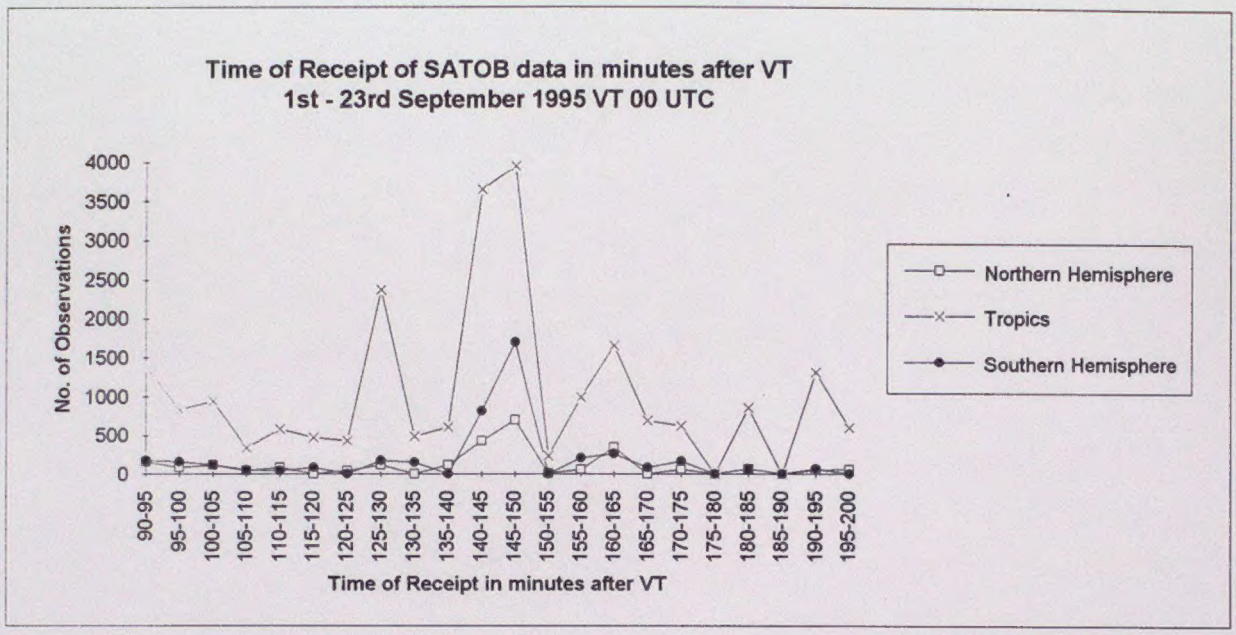

Accumulated No. of Observations vs Time of Receipt of AIREP data in minutes after VT
1st - 23rd September 1995
Accumulated No. of Observations
25000
20000
15000
10000
5000
0
<VT+90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

FIGURE A.3


Time of Receipt of SATOB data in minutes after VT
1st - 23rd September 1995 VT 00 UTC
No. of Observations
4000
3500
3000
2500
2000
1500
1000
500
0
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

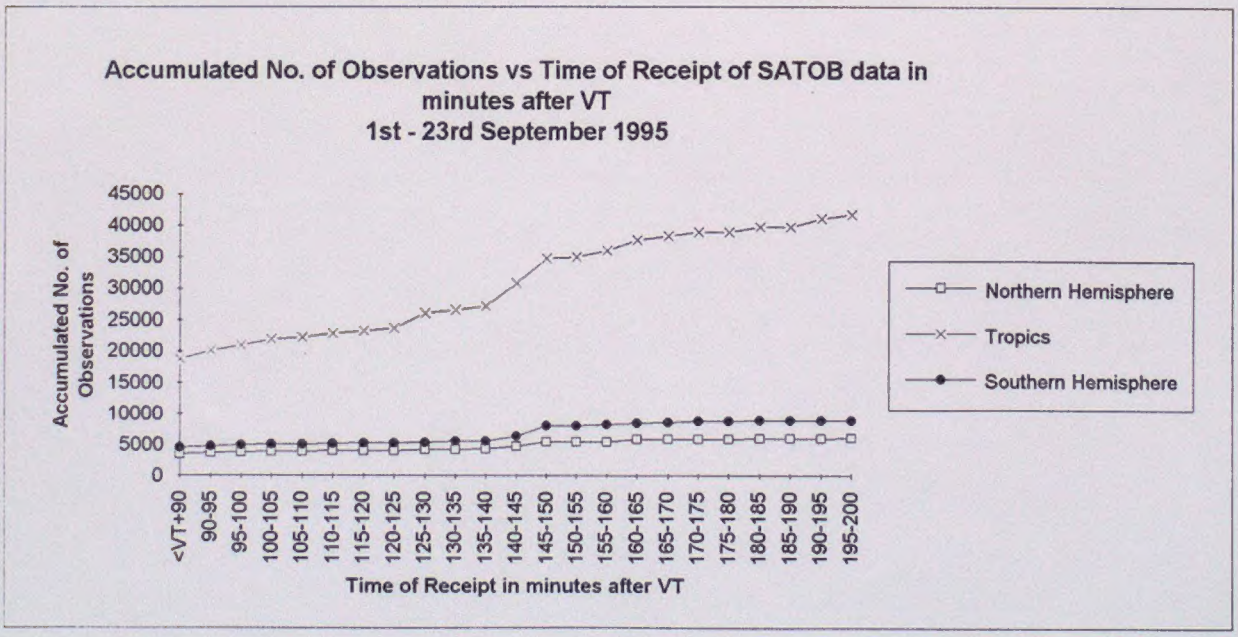
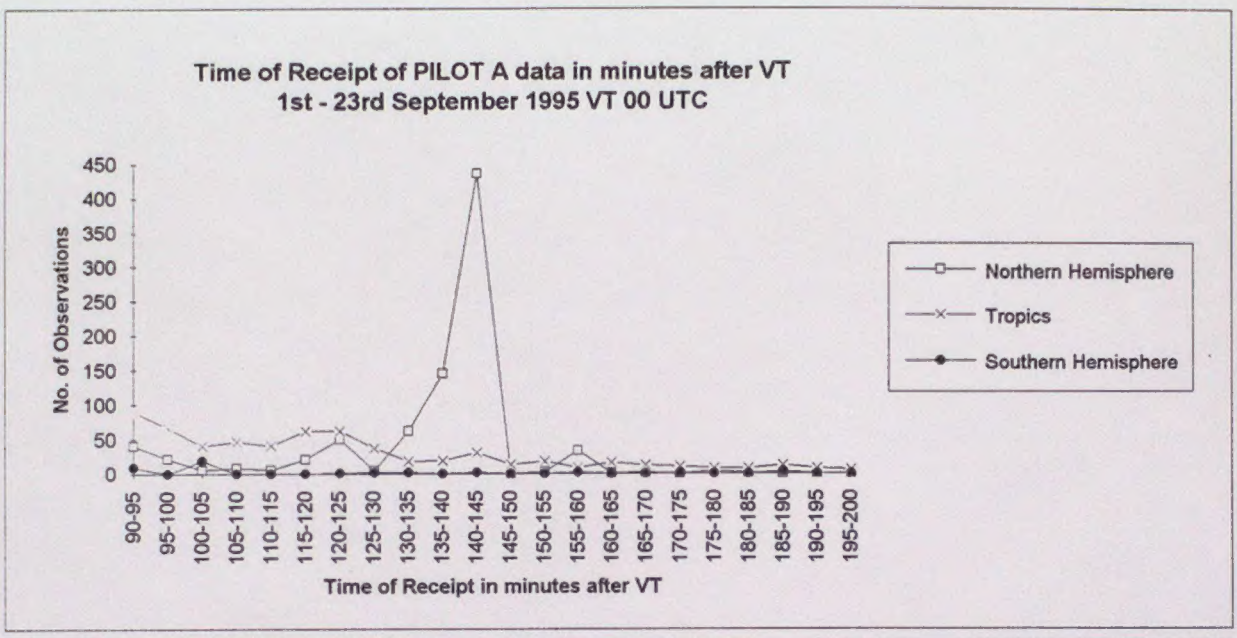

Accumulated No. of Observations vs Time of Receipt of SATOB data in minutes after VT
1st - 23rd September 1995
Accumulated No. of Observations
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
<VT+90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

FIGURE A.4


Time of Receipt of PILOT A data in minutes after VT
1st - 23rd September 1995 VT 00 UTC
No. of Observations
450
400
350
300
250
200
150
100
50
0
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

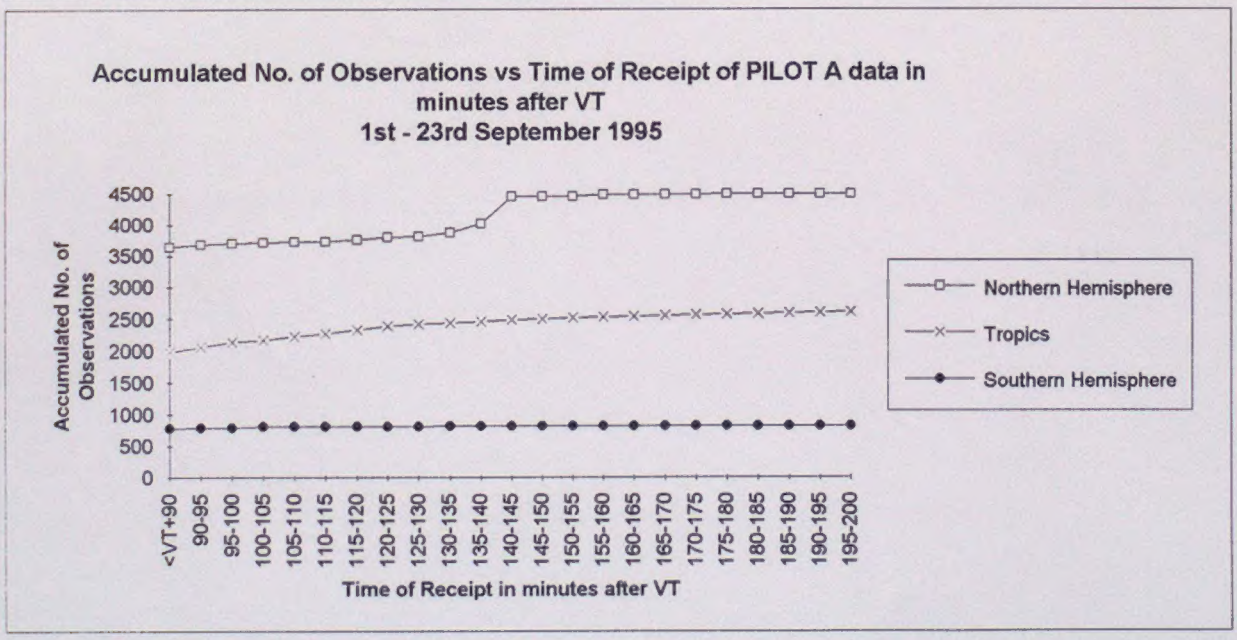

Accumulated No. of Observations vs Time of Receipt of PILOT A data in minutes after VT
1st - 23rd September 1995
Accumulated No. of Observations
4500
4000
3500
3000
2500
2000
1500
1000
500
0
<VT+90
90-95
95-100
100-105
105-110
110-115
115-120
120-125
125-130
130-135
135-140
140-145
145-150
150-155
155-160
160-165
165-170
170-175
175-180
180-185
185-190
190-195
195-200
Time of Receipt in minutes after VT
Northern Hemisphere
Tropics
Southern Hemisphere

FIGURE A.5